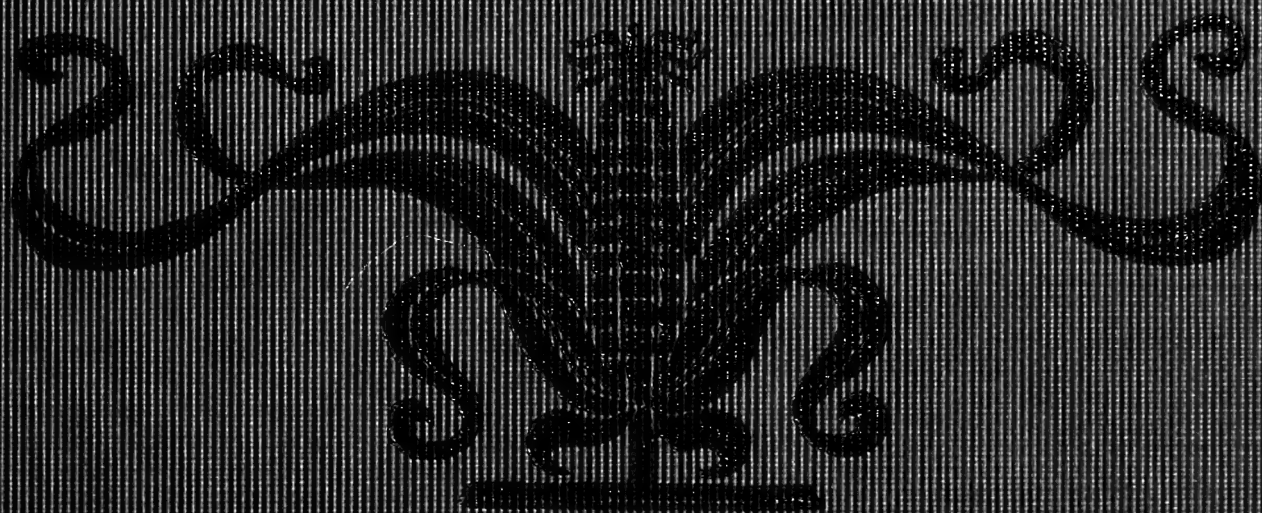


AN INTRODUCTION TO AGRICULTURE

A. A. UPHAM & G. A. SCHMIDT





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**AN INTRODUCTION TO
AGRICULTURE**

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TO
AGRICULTURE

BY

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*NEW EDITION THOROUGHLY REVISED.
NEW PROBLEMS AND QUESTIONS.*



D. APPLETON AND COMPANY
NEW YORK CHICAGO

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PRINTED IN THE UNITED STATES OF AMERICA

PREFACE

The progress that has been made in the teaching of agriculture and the emphasis given to the subject through the pressure of the world war have made a revision of the "Introduction to Agriculture" desirable. When this book was published eight years ago, few of the states of the Union had published courses of instruction in agriculture. Most of the states have now done so and the authors have compared these courses and selected the salient points as a basis for an elementary book. Any state will find this book a text admirably fitted to its required course of study in agriculture.

The high cost of living has turned the attention of many people towards the raising of poultry and garden products; the book will be found especially strong in these two particulars and will therefore serve as a valuable reference book in public libraries and in homes of amateur farmers. Throughout the volume special emphasis has been given to those phases of agriculture in which a child is most easily interested and in which he can most readily become useful. The new chapter on home projects directs him in such work.

The book contains many questions and problems, mostly new, and of a kind that the practical student

ought to be able to answer. These questions and problems are not directly answered in the text but require the student to think, investigate, or act.

Grateful acknowledgment is made for cuts furnished us by the United States Department of Agriculture, by colleges of agriculture and by business concerns interested in agriculture. Credit has in all cases been given unless by accident it has been overlooked. If any such omissions have occurred the authors will be glad to make the necessary correction in subsequent editions if their attention is called to the omission.

A. A. UPHAM.

G. A. SCHMIDT.

CONTENTS

CHAPTER		PAGE
I	IMPORTANCE OF THE STUDY OF AGRICULTURE .	1
II	THE NATURE OF PLANTS	6
III	THE SOIL	14
IV	WATER IN THE SOIL	27
V	TILLAGE	39
VI	ELEMENTS OF PLANT FOOD IN THE SOIL . .	47
VII	SOIL FERTILITY	56
VIII	LEGUMINOUS CROPS AND ROTATION OF CROPS .	70
IX	CORN	79
X	WHEAT, BARLEY, RYE, AND OATS	96
XI	FORAGE CROPS	108
XII	OTHER FARM CROPS	116
XIII	SEEDS	128
XIV	PLANT ENEMIES	136
XV	THE FARMER'S FRIENDS: BIRDS, TOADS, BEES	151
XVI	GARDEN CROPS	161
XVII	HOME GARDENS	168
XVIII	PROPAGATION BY CUTTINGS AND BY OTHER MEANS	182
XIX	THE ORCHARD	189
XX	SPRAYING AND SPRAYING SOLUTIONS . . .	203
XXI	FEEDING ANIMALS	214
XXII	POULTRY	231
XXIII	CATTLE	248

CONTENTS

CHAPTER		PAGE
XXIV	MILK AND ITS PRODUCTS	270
XXV	HORSES	280
XXVI	SWINE AND SHEEP	289
XXVII	GOOD ROADS — FORESTRY — HOME AND SCHOOL GROUNDS	310
XXVIII	SCHOOL-HOME PROJECTS	323
XXIX	SCHOOL GARDENS	336
	APPENDIX	349

AN INTRODUCTION TO AGRICULTURE

CHAPTER I

IMPORTANCE OF THE STUDY OF AGRICULTURE

1. Why Agriculture Should be Studied.—Agriculture touches the life of all of us. The three great needs of a human being are food, shelter and clothing. With the exception of sea foods and salt most of our food is produced by the farmer. Nearly all our clothing is made from cotton, wool, silk and leather which are the products of agriculture. Our houses are largely built of wood which grows on the land and even now in some parts of the world requires attention like other crops. While many of the pupils who study agriculture in school never become farmers, an increasing number are finding that they have need of what agriculture teaches. Every one should know something about the production and the qualities of the different foods he eats. In rural schools, especially, pupils need to learn both the reasons for the work which is done on the farm, and the ways in which successful farmers do it.

Schools to-day are trying everywhere to give pupils knowledge which will be of practical use to them in life; and, from this point of view, no study is more

2 AN INTRODUCTION TO AGRICULTURE

important than agriculture. No pupil comes to understand the subject by crowding his mind with facts or by memorizing his text book. He must observe the things he is studying about, wherever he finds them — in the fields or on the home farm. These facts of agriculture are always about him, and are full of interesting matter for thought and for careful study, so that the subject of agriculture offers any pupil plenty of opportunity for the mental discipline which his growing mind needs, even while at the same time, it gives him knowledge he can put to practical use.

2. Relation Between Success of Farmers and Their Education.—On reading the preceding topic, the thought may arise, “The more education a man has, the poorer farmer he will be.” If education means, as it formerly did, a knowledge of the classics, ancient history, and the higher mathematics, the thought may very likely be true. But the word education, in this connection, means gaining the knowledge and the judgment regarding the underlying principles by which the farmer works, in order to get successful results. Any sensible boy readily can see that knowing the principles of raising and feeding dairy cattle, and practice and skill in the use of the Babcock test, will lead to more success in dairying; that a knowledge of plant growth will lead to a more productive orchard; or that knowing how to improve plants and make the soil more fertile, will lead to the production of bigger and better crops. More than that, any boy or girl who has studied agriculture should be able to conduct a home garden project, or any other farm project, and get

better results than he would if he had not studied agriculture.

3. Increased Production Due to Better Knowledge.— There are on record many cases, where a person, having more carefully applied the underlying principles of agriculture, has obtained unusually good results in the very places where before, when these principles have been ignored, the results have been complete failures. One of the most striking of these occurred on "Poorland Farm," in southern Illinois. In 1903 Prof. Cyril G. Hopkins bought this farm of 300 acres for less than \$20 an acre. On a 36 acre-field of this farm, which was so poor that it had been abandoned, he raised, in 1913, 1278 bushels of wheat, or $35\frac{1}{2}$ bushels to an acre. He got this result in a very practical and economical way; he spent \$1.75 per acre each year for the materials with which he improved the field.

Here is another case — one which shows what intelligence did for an Iowa farmer. In three years, by keeping dairy records, by weeding out poor cows, and by proper feeding and management, this farmer increased the average yearly yield of butter fat of his herd from 207.7 lbs. to 341.98 lbs. This made the products of each cow worth \$75 more a year to him than the cost of keeping her, while, at the beginning of the three years, each cow had been worth only \$22.12 more than the cost of her keep. Thus, by putting to practical use his knowledge of dairying, this farmer increased the average net income of each of his cows 39 per cent.

4 AN INTRODUCTION TO AGRICULTURE

Eighteen Ohio farmers kept records of their flocks of hens for one year. The best flock of 100 hens showed a profit of \$247 over the cost of feed, and the poorest flock showed a profit of only \$15. Here again better knowledge of the underlying principles of poultry management made a difference in net income of \$222 in favor of the best flock.

4. Growth of Agricultural Instruction.— The last fifteen years has seen a remarkable development in the teaching of agriculture. This development has been due largely to the activity in agricultural interest aroused by the United States Department of Agriculture and by the State Colleges of Agriculture. Under their guidance, agriculture, the oldest industry of man, and the most necessary for sustaining life, has reached a stage where its importance is appreciated by every thoughtful man. No intelligent citizen to-day is entirely ignorant of the science of agriculture.

As a result of this aroused interest, there has developed a mass of good writing on agricultural subjects. Hundreds of books on all phases of agriculture, written by trained specialists, are found in public libraries. The circulation of agricultural periodicals is wide-spread throughout the country; and the Government, State Agricultural Colleges and Experiment Stations, as well as railroads, and private business organizations, are constantly putting forth the results of their investigations in the form of bulletins. No student in the public schools of America to-day can afford to overlook or slight a subject of such universal importance as agriculture.

QUESTIONS AND PROBLEMS

1. Give at least three reasons why agriculture should be taught.

2. Give some instances where a better knowledge of farming has given better results.

3. What should a man know who wishes to buy good potatoes? Good corn? Celery? Meat? Butter?

4. What do you know about the growth of the agricultural instruction in the high schools of your county? In your state agricultural college?

5. What are some of the things your state college of agriculture has done which have benefited the farmers in your community?

6. What agricultural bulletins and periodicals does your father receive? In what articles in them are you most interested?

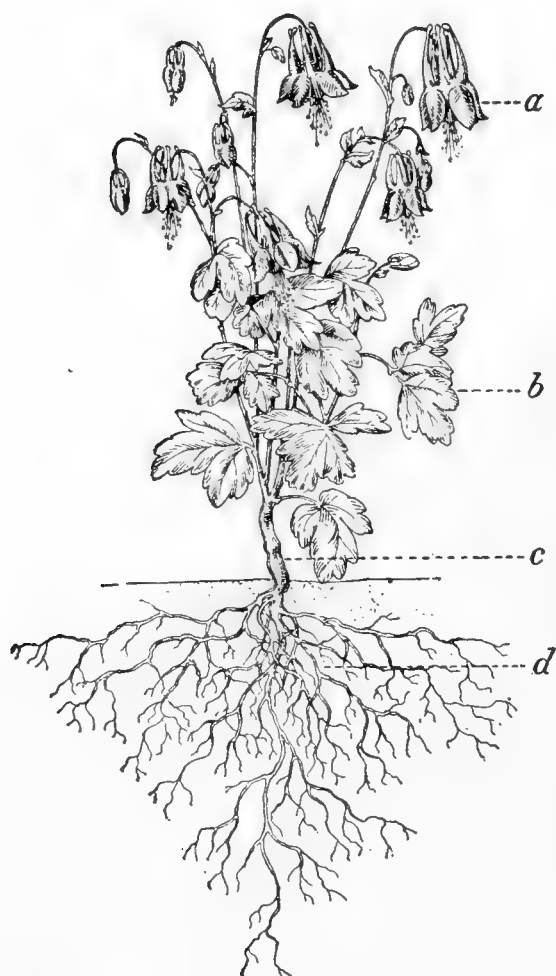
7. Do the grade cows in your community give better milk and butter fat yields than the scrub cows?

CHAPTER II

THE NATURE OF PLANTS

5. Importance of Plants.—Plants are very important, for without them animals could not live. Animals

depend upon plants for their food. A cow eats grass and changes this into milk and meat. We eat both plant and animal matter but the animal matter we eat, such as meat, eggs, milk, etc., comes from animals that have made these substances from plants. Later we shall learn how all green plants can make, from the materials they absorb from the soil and air, the substances we commonly call foodstuffs, such as protein, sugar, starch, and fat. No animal can make these foodstuffs but all green

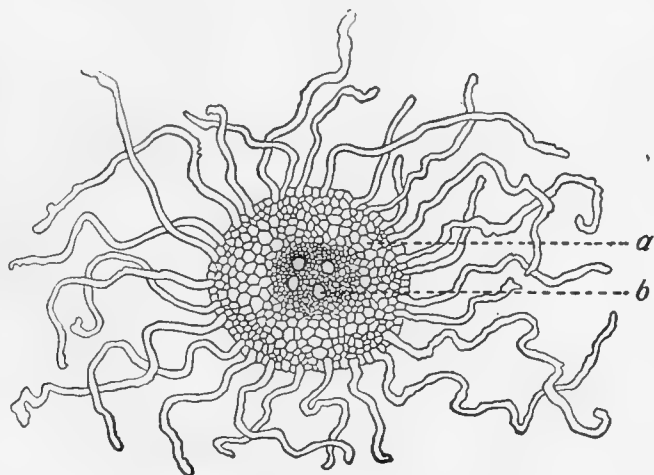


TYPICAL PLANT (*Columbine*)
Showing, *a*, flower; *b*, leaf;
c, stem; *d*, roots

plants can.

6. The Parts of a Plant.—Most plants have roots, stems, leaves, flowers, fruits, and seeds.

Roots.—The roots reach out through the soil, hold the plant in place, and absorb raw food material for it. They conduct the absorbed liquids up to the stem of the plant. In plants which live more than one year, the roots also act as a storage house for reserve food materials. Large roots branch into smaller roots, until they become fine, delicate rootlets. The tiny rootlets bear the still finer root hairs. These root hairs are so very fine and delicate that they appear as a dense white fuzz on young seedlings.



CROSS SECTION OF A ROOT

Showing the Root Hairs. *a*, bark cells;
b, duct for passage of water and air

When corn, oats, or other seeds are tested for their germination power the root hairs may be seen easily. The root hairs are very important, as it is they which absorb from the soil the substances which the plant uses in making food.

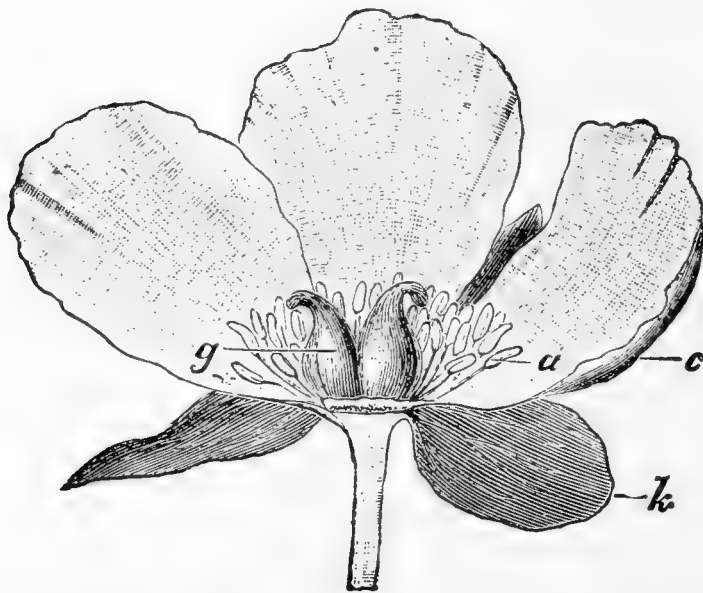
Stems.—The stem is the framework on which leaves, flowers and fruits are borne. It may be very short and thick as the “crown” of the turnip or beet; it may be very slender and light as in grains, or it may be large and strong as in the trunk of a tree. By means of numerous tubes the stems also connect the leaves with the roots. The water and other raw food materials absorbed by the root hairs must be taken up into the leaves where these raw food materials are manufactured

8 AN INTRODUCTION TO AGRICULTURE

into plant food. Some of this manufactured plant food must then be carried back from the leaves down to the stem and roots, so that these parts may be nourished and grow. Roots and stems, or any other parts of a plant, cannot be nourished by the raw food materials absorbed from the soil, until these materials are made into manufactured plant food in the leaves.

Leaves.—The leaves of plants are generally broad, thin and green. The leaves are the factories in which the raw food materials, gathered by the roots and by the leaves themselves, are made into plant food for the use of the entire plant. The large part of the leaf is the blade. Running through the center of the blade is the thickened *midrib*, and branching out from the midrib

are the *veins*. The midrib and veins have vessels which are in direct communication with the vessels of the stem.



FLOWER OF PEONY.—SHOWING THE FOUR SETS OF FLORAL ORGANS

k, the sepals, together called the calyx; *c*, the petals, together called the corolla; *a*, the numerous stamens; *g*, the two carpels, which contain the ovules.—*Strasburger*.

Flowers. — In order to get a clear idea of the parts of a flower, separate into its parts a simple flower like a morning glory or a single

petunia. You will notice first a sort of a cup where the flower rises from its stem. This is the *calyx*. It

is generally green and often divided into parts, like little leaves. Inside this green calyx cup is the *corolla*, the colored or showy part of the flower which attracts our attention. The divisions of the corolla are called *petals*. In the heart of the flower you will find a cluster of slender threads, called *stamens*, each with an enlargement containing a fine powder, called *pollen*. In the very center of the flower, surrounded by the stamens, is the *pistil* or seed forming organ. This is usually largest at the base, just above the point where it connects with the stem, and it is in this enlarged part that the seeds form and develop.

7. Pollination and Fertilization.—In order that a seed may be formed in the seed organ of a flower, it is necessary that pollen shall fall or be placed on the upper part of the pistil. This transfer of pollen from the upper part of the stamen to the upper part of the pistil is called *pollination*. Sometimes the wind does this work for the flower, and sometimes an insect. When the upper part of the pistil is ready to receive the pollen, it is usually sticky so that the pollen will cling to it. The pollen grain soon begins to germinate and sends a shoot down into the enlarged part of the pistil, or *ovary*, where it reaches the forming seed. The contents of the pollen grain mingle with the contents of the forming seed and make a fertilized seed. The process is called *fertilization*. If a forming seed has been fertilized it will grow and develop into a seed; if not, it and all the parts of the flower will wither and die. Missing kernels of corn are a common example of forming seeds which have never been fertilized.

8. Fruits and Seeds.— When a flower has been fertilized, the ovary, and in some cases, adjacent parts, continue to grow and develop into the *fruit*. When a flower is not fertilized, no fruit is formed. A mature or ripened ovary, together with its contents, always is the fruit of a seed forming plant. Sometimes, as in the case of corn or oats, the seed constitutes the entire fruit; and often, as in the apple, the seed is but a very small part of the fruit.

Seeds.— The fruit continues to grow until the seeds are ripe. At first the seeds contain much water and they must be dry before they can be stored away safely. This is why corn and grains are shocked in the field at harvest time, and seed corn is gathered and hung where it will dry quickly and not freeze while it contains so much water. After seeds are dry, freezing does not injure them. There are many different kinds of seeds, but all of them contain both a little immature plant, called the *germ*, and some stored up food. In a bean seed the little plant is easily seen.

Soak some lima beans and some kernels of corn in water for a few days. Then remove the seed coat of the bean and notice the little root projecting up between the halves of the seed and the little leaves between them. Cut the kernels of corn lengthwise through the center and notice the little stem and root.

Classes of Seeds.— There are two common classes of seeds. The bean is a good example of one class and corn of the other. If you try to divide the bean seed, you will see how easily it separates into two halves. Each of these halves is a thickened seed leaf and is

called a *cotyledon*. Projecting out between the cotyledons is a small pointed root-like structure and between them is a pair of little leaves. These parts are all attached to each other and form the new plant when the seed germinates. The corn seed differs from the bean in that it has only one cotyledon, in which the little root and leaves are imbedded.

9. How a Plant Grows.— You have seen how a plant begins to grow from the seed. It sends a shoot upward toward the light and a root downward into the soil. The upward shoot becomes the stem and leaves, and the downward shoot, the root. The root, as it grows, soon divides into many branches which penetrate the soil in all directions.

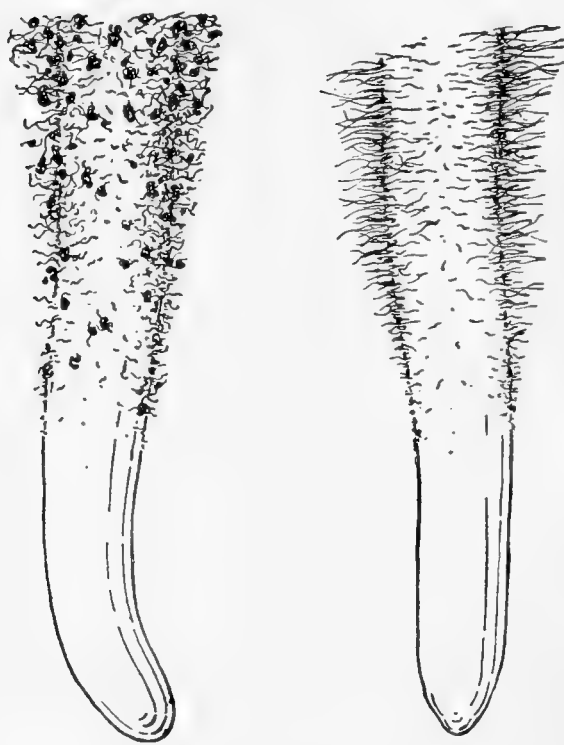
Place some large seeds, as beans, peas and corn, in water. Put some in damp sand and sawdust. Watch their development and continue to study the little plants as they grow.

10. How the Plant Gets Its Food.— The plant starts its life by feeding on the manufactured food stored in the seed. But as soon as its leaves have reached the sunlight and the roots have developed root hairs, the plant absorbs the raw materials out of which it makes its own food. Air, water, and mineral salts in the soil water are the plant's raw food materials.

The green tissues of a plant have the power to combine the water and the mineral substances from the soil, and the gases from the air, to make food for the plant. This process can take place only in the sunlight and the leaves are the principal organs manufacturing this food. In the process the leaves return to the air,

through their breathing pores, both a gas which we call oxygen, and water, in the form of vapor.

II. Conditions of Growth.— In order to grow well,



ROOT TIPS OF CORN

Showing root-hairs and their position in reference to the growing tip

the plant must have the proper conditions of heat, water, air, light, and raw food. Until the weather is warm most seeds do not even sprout. Light is very essential to the life of plants; in the dark they stop growing or grow only a little and weakly. A certain amount of water must be in the soil within reach of the plant, or it will wither and die. There must

be free circulation of air, and the proper amount and kinds of raw food materials must be in the soil.

In two wide-mouthed bottles place some damp sand or saw-dust. After soaking a handful of oats in water over night, place half of the seeds in each bottle. Cork one bottle very tightly, and leave the other open. Watch the results. How can you account for the difference?

QUESTIONS AND PROBLEMS

1. Give a list of flowers pollinated by insects. By the wind.
2. Would it be better to bunch the corn in a garden or plant it in a single row? Explain.

3. Make a list of plants having one cotyledon. Having two.

4. The seeds of what plants are used for the manufacture of oil? Of starch?

5. Draw a longitudinal section of some flower and label all parts.

6. Why cannot the plant use stones for food materials?

7. In what form is the raw plant food usually found in the soil? Is this good or bad?

8. In transplanting plants why should they not be pulled out of the ground?

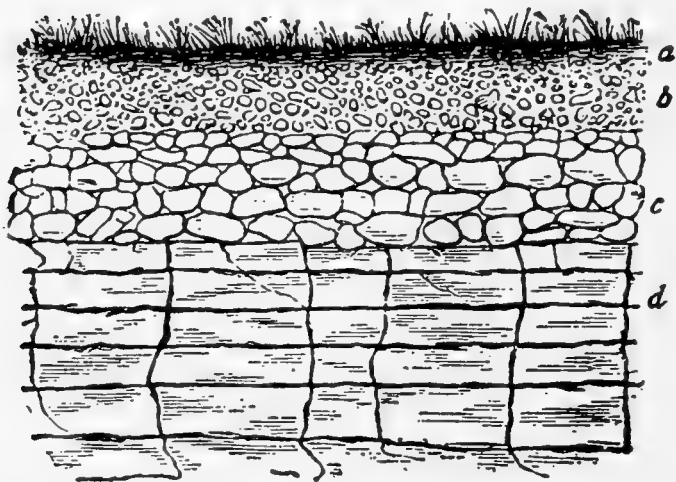
9. Name the plants whose seeds are especially rich in protein.

CHAPTER III

THE SOIL

“The soil is the greatest natural resource of the Nation.”

12. The Composition of Soils.— By soil we mean that part of the earth's crust in which plants grow. It is a loose, decomposed layer of mineral matter mixed with more or less vegetable and animal matter. The soil furnishes plants with water and raw food materials, and gives them an ideal place in which to spread their roots so that they may easily support the parts which live above the ground. The soil varies greatly in depth.



SOIL FORMED FROM ROCK UNDERNEATH

a, soil with grass growing in it; *b*, subsoil, coarser and more rocky; *c*, coarse, loose rock; *d*, rock in layers, cracked. *d* changes to *c*, *c* changes to *b*, and *b* to *a*.

In some places it may be only a few inches deep, and in others, many feet. The top layer of the soil is often called the top or surface soil, and it is generally darker in color than the layer beneath it, called the subsoil. The subsoil varies greatly in depth and extends

down to the underlying layer of bed rock. The top soil

is darker than the subsoil because it contains more vegetable matter. The subsoil is generally harder, colder, and less suitable for plant growth than the top soil.

13. Origin of Soil Materials.—All the mineral particles in soils have been formed from the breaking down or crumbling, and decomposition of rocks. These processes never cease in the soil and are continuously leaving rock particles of various sizes. In many soils there is a gradual grading from fine particles on top, down through coarser and coarser materials until the solid rock is reached. The different agents which nature uses to bring about the breaking down and the decomposition of rocks are:—water, frost, changes of temperature, wind, plants, animals, gravity, acids, and the gases, oxygen and carbon dioxide.

Refer to your geographies and find out how each of these agents accomplishes this work.

14. Source of Organic Matter.—Plants on the surface of the ground, and also their roots, wither and die, and some of the materials they contain slowly become a part of the soil. The original richness of the pioneer soils of the western prairies was due to the benefits of the vegetable matter which the roots and tops of the prairie grasses had been forming for many years.

The animal matter in the soil comes from the remains of animals which have died. The amount of this is always very small. The dead animal and vegetable matter, accumulating both in the soil and on the

surface decays and gives the dark color to our soils. We call this decaying animal and vegetable matter *humus*. Quite often the term *organic matter* is used in speaking of soils. This term refers to all the animal and vegetable matter. It includes not only all the humus in soils but also the plant and animal matter not sufficiently decayed to be called humus.

15. Formation of Soils.—The soil on which your schoolhouse is built has been formed in one of two ways. The soil particles may have been brought to the place by some agent such as a glacier, running water, the wind, gravity, or by volcanic action; or else the particles were formed by the breaking down of the solid rock which once covered that particular spot.

Refer to your geographies and read again just how these agents have formed, or transported and deposited soils.

16. Classes of Soils.—Most soils are made up chiefly of four different kinds of materials — sand, silt, clay, and humus. Sand, silt, and clay are the mineral parts of the soil; the coarsest of these is sand, the finest is clay, while silt is finer than sand but coarser than clay.

Sandy Soils.—When you rub sandy soils between your fingers, you find that they feel gritty. They drain and dry out quickly because the pore spaces between the particles of sand are large. Air circulates freely in them and they warm up quickly. Sandy soils are adapted to early crops.

Clay Soils.—Clay when dry and loose is like a very fine powder. Clay soils are just the opposite of sandy

soils. The pore spaces between the particles are exceedingly small; in fact, so small that the tiny particles of clay can easily unite themselves into a sticky mass. Clay soils drain and dry slowly and admit little air. When they dry after rains, they are compact and often form on the surface a hard crust which makes it difficult for the air to circulate in them. Clay soils are spoken of as cold soils. They are best adapted to the small grains and grasses.

Loam Soils.—When sand, silt, and clay are found in a soil so evenly mixed that there is not much more of one kind of soil than of another, we call the soil a loam. Loam soils are generally considered the best, because they may be used to grow to advantage all of our common crops.

They have none of the disadvantages of sandy and clay soils, and still they have most of their good qualities. There are many kinds of loam soils, such as: silt loam, sandy loam,

clay loam, etc.; in these the silt loam contains slightly more silt, the sandy loam, slightly more sand, than is found in a loam soil.

Marsh Soils.—There are also soils which contain so large a part of organic matter that they are very black in color. Once upon a time these have been marshes, but they are now drained, and have become what is



SOIL WITHOUT HUMUS

Notice how hard and compact this soil appears.—*Courtesy of the International Harvester Company.*

known as muck and peat soils. Peat soils contain more organic matter than muck soils, and both kinds, when



SOIL RICH IN HUMUS

Note the difference between this soil and the hard, baked soil.—*Courtesy of the International Harvester Company.*

properly drained, generally make good soils.

Light and Heavy Soils.—If we had equal volumes of sand, silt, and clay, all in a loose and dry condition, and should weigh them, we would see that the

sand would weigh the most, and that the clay would weigh the least. Usually, however, you will hear a sandy soil spoken of as light and a clay soil as heavy. These terms do not refer to the actual weights of soils, but to the ease with which they are worked. Sandy soils are easier to plow and to cultivate than clay soils, as the “pull” required is less.

17. Other Constituents of Soils.— Besides mineral and organic matter, soils also contain water, air, and many kinds of living organisms, such as worms, insects, molds and bacteria.

Earthworms.— Earthworms are very beneficial to soils, because the channels or burrows they make allow water and air to penetrate more rapidly. Earthworms help drain the soil and by means of their channels give roots an easy chance to penetrate into the harder subsoil.

Soil Bacteria.— Good soils literally teem with bac-

teria. There are both good and bad bacteria in the soil. Some of the good bacteria act upon the organic matter and change it in such a way that much of the insoluble matter which composes it, is made soluble. This process sometimes is called decay. From this decay, nitrogen, one of the necessary raw foods of plants, is set free in such a way that the plant can use it for raw food.

Other soil bacteria live upon the roots of leguminous plants, as on the bean, clover, alfalfa, etc. These also are good bacteria, because they make use of the nitrogen in the soil air and change it into a nitrate, a soluble compound which the plant, upon whose roots the bacteria lives, uses for a raw food material.

Soil also contains bad bacteria. These bad bacteria are most numerous and active in wet soils. The bad bacteria do not aid in making raw plant food ready for the use of plants.

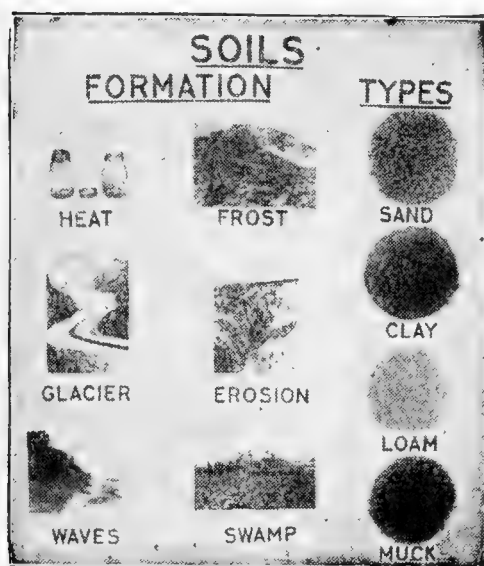
Air in the Soil.—Roots of plants, germinating seeds, worms, insects, and bacteria, all need air to live. Air in the soil is necessary also because the gases it contains, oxygen and carbon dioxide, help in the decomposition of substances in the soil.

Humus in Soils.—Humus is one of the most important constituents of all our soils, and without humus no soil is of much value. A soil containing little or no humus is generally barren. Humus adds to the soil raw plant food, principally nitrogen. Humus not only feeds the bacteria in the soil, but it is their principal source of food.

18. Humus Forming Materials.—Manure forms

a great deal of humus, and this fact makes manure of more value to the farmer than commercial fertilizers in the improvement of most poor soils. Sod, stubble, and roots of crops, weeds, corn stalks, straw, and in fact, all vegetation, add humus to the soil. This shows us why manure should never be allowed to lie in piles in a barnyard for a long period of time until it has decomposed and lost much of its value as a fertilizer, and why straw stacks and corn stalks should never be burned, but be made use of by farmers to improve their land. Another excellent way to add much humus forming material to a soil is by growing a crop which is adapted to being plowed under; such crops planted for such a purpose are called green manure crops.

19. Soil Acidity.—When we mentioned the differ-



Courtesy of the Soil Improvement Committee of the National Fertilizer Association.

ent agents by which soil is made, we spoke of acids. Vinegar and lemon juice are good examples of acids. The greater part of many acids is water, and this is also true of vinegar and lemon juice. If we put a little piece of old plaster in a glass and cover it with vinegar or lemon juice we shall see little bubbles passing up through the liquid and if we put the glass close

to our ear we shall hear a sizzling noise.

Try this experiment.

If we put a drop of vinegar or lemon juice on a piece of blue litmus paper we shall see the blue paper turn red.

Any druggist will give you a few strips of litmus paper with which you can try this experiment.

All substances which act toward old plaster and litmus paper as the vinegar and lemon juice do are called acids. The small roots of plants contain an acid, some of which is always entering the soil.

Prove this by crushing a little root against a piece of blue litmus paper.

The decay of organic matter and the decomposition of certain mineral soil particles also add acids to the soil. The gas carbon dioxide which occurs in the air makes a mild acid when it unites with water and some of this acid enters the soil. If there are any substances in the soil which have the same properties which the piece of plaster has, these soil acids act upon them just as the vinegar or lemon juice acts upon the plaster in the glass. If there is enough of these materials present in the soil, the acids will soon be destroyed. Limestone and other forms of lime have the same properties which the plaster has and this is why these materials are often put upon an acid soil to destroy its acidity or to sweeten it.

20. Testing Soils.—It is a simple matter to test soils for acidity. Take a handful of wet soil and form it into a ball. Break the mud ball into halves, and place a piece of blue litmus in the center on one of the halves, and cover with the other half. After five

minutes break the ball, and if the paper now appears pink, the soil is sour. If you need water to moisten the soil, use soft water which has no effect upon the



IN MOST CASES LIME SHOULD BE APPLIED TO THE LAND AFTER IT IS PLOWED AND PARTLY FITTED.—*The Country Gentleman published by the Curtis Company, Philadelphia.*

litmus paper. Handle the soil as little as possible as the hands generally contain an acid which changes the color of the paper.

Test soils with litmus paper.

We also can tell easily if a soil itself contains lime by adding vinegar or hydrochloric acid to it as we did to the plaster in the glass.

Try this experiment. Bubbling and sizzling indicate the presence of some form of lime.

We can safely say that the majority of our farming soils contain too much acid and too little lime for the greatest crop yields. In every state the liming of soils is a regular farm practice.

21. Disadvantage of Acid Soils.—The acid in the soil checks the growth of our good bacteria which make nitrates from the humus and from the soil air; in many places the actions of bacteria almost stop because of the large amounts of acid in the soil. The lack of lime also has an effect upon the physical structure of the soil so that it is apt to be more compact than if lime were present.

22. Appearance of Acid Soils.—Acid soils often bear certain outward signs which show that they are acid, such as the failure of clover, alfalfa, and other legumes to grow well; often these crops will not make any growth at all on acid soils. The appearance of sheep sorrel, moss, and horsetails is also an indication that the soil is acid. Liming the soil destroys the acids, and when this is done, we say the soil has been sweetened, because the soil acids have a sour taste just as vinegar and lemon juice have.

To each of two tumblers, three-fourths full of water, add and stir a tablespoonful of soil. Add enough lime water to one tumbler to fill it. Note how the settling and clearing of the two tumblers differs. Adding lime to a soil granulates it as the lime did in this case.

23. Soil Surveys.—The United States Government in connection with the State Agricultural Colleges, is

making soil surveys in all the states. A soil survey is a very careful study of the soil, made in the field and usually considers the following: —

- Origin and formation of the soil.
- The lay of the land.
- Whether originally timbered or prairie.
- Structure and depth of soil.
- The physical and chemical composition.
- The kind of soil — class and type.
- The drainage.
- The value, based on productiveness.
- The reaction.
- Suggestions for improvement.

In brief, a soil survey is an inventory of a soil and is intended to be of practical help to farmers so that they may, without any cost, be able to study how to make the best possible use of their soils. Each soil survey usually covers a county; that is, the county is the unit. A map showing the topography, and by means of different colors, the soil types, accompanies each bulletin containing a survey. These surveys may be obtained from the State Agricultural Colleges or from the United States Department of Agriculture at Washington. Not all counties in the United States have been surveyed, but the plan is to make a survey of every county which has much agricultural land and which is fairly well populated.

Each school should inquire from its State Agricultural College whether its county has been surveyed, and, if it has, obtain the soil survey bulletin and map. There is no better

way to get as large an amount of valuable information about the soil of any particular county as by studying its survey.

QUESTIONS AND PROBLEMS

1. How deep is the surface soil in your garden?
2. What do you suppose was the origin of the surface soil you removed to get its depth?
3. Is the soil in your garden a clay, sandy, or loam soil? How do you know?
4. Have you ever seen any muck soils in your vicinity? Describe their location.
5. What do you suppose is the cause of the bogs so often seen on muck land?
6. Would a rock crumble more where the climate is even or where it is changeable?
7. What are your reasons for believing that the surface soil is better than the subsoil?
8. If 96% of a sample of limestone may be dissolved and carried away by water how many cubic feet of such limestone would make 12 cubic feet of soil?
9. Do the farmers in your community make a regular practice of liming the soil?
10. Has a soil survey been made of your county?

Bulletins for Sale by Superintendent of Documents, Washington, D. C.

Soil Surveys 15 cents each. Send for list of your state.

Also issued by the State Agricultural Colleges.

Soils of the United States, Soils Bulletin 55, 45 cents.

Study of Soils of the United States, Soils Bulletin 85, 25 cents.

Soil Erosion, Soils Bulletin 71, 35 cents.

Some Organic Soil Constituents, Soils Bulletin 88, 10 cents.

Important American Soils, Yearbook Sept. 563, 5 cents.

Farmers' Bulletins.

Liming Soils, F. B., 257.

Renovation of Worn-Out Soils, F. B., 245.

Management of Muck Soils in Ind. and Mich., F. B., 761.

Management of Sandy Farms in Ind. and Mich., F. B., 716.

A Simple Way to Increase Crop Yields, F. B., 924.

The Principles of Lining Soils, F. B., 921.

CHAPTER IV

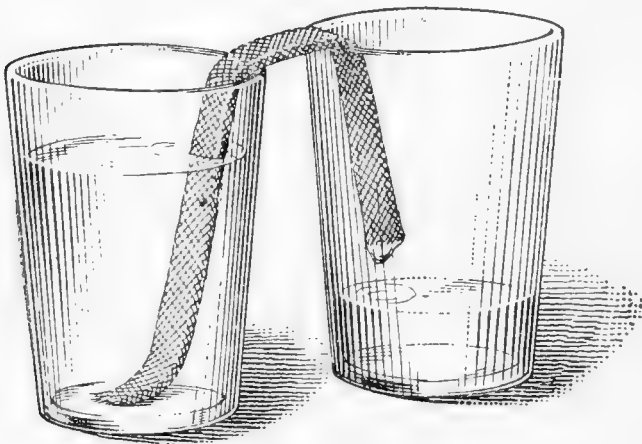
WATER IN THE SOIL

24. The Importance of Water to Plants.— Without plenty of water in the soil, plants cannot thrive. You already know why this is so. Water itself is a raw food material, and in the water is also dissolved all the other raw food materials which a plant takes from the soil. More than that, water is necessary to conduct the raw food materials from the roots to the leaves and to conduct some of the manufactured food from the leaves back to the stem and roots.

25. The Movement of Water in the Soil.— Part of the water that falls during a rain sinks into the soil in the little pore spaces between the soil particles. You know how the water sometimes runs through the soil in a flower pot and comes out of the hole at the bottom. If the soil is dry, and you give the plant only a little water, none of the water runs out, but all of it is held among the soil particles, which now look moist instead of dry. That water which sticks to the particles of soil is called *film* or *capillary water*, because it surrounds the particles and also partly fills the small pore spaces, or capillaries, between them. The water which runs through the soil is called *free water* because it is free to drain. The water that comes into a hole which is being dug in the ground, is free water.

Evaporation.— If we add considerable water to a flower pot, the free water will run out through the hole in the bottom. The soil on the top soon begins to dry out. The water in this top soil passes off into the air in the form of vapor. We call this process *evaporation* and we say the water evaporates.

How Water Rises in the Soil.— When the water from the upper surface evaporates, the film of water surrounding these upper particles gets thinner. The film



EXPERIMENT SHOWING CAPILLARITY

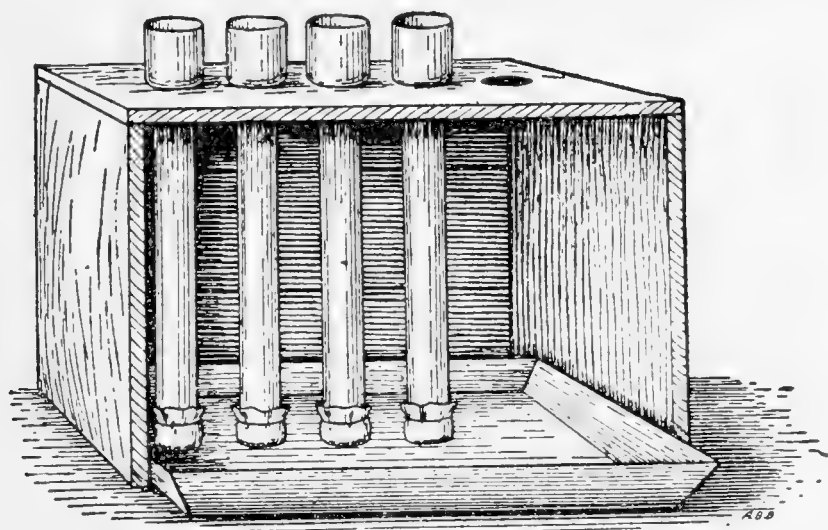
of water is thickest nearest the bottom and this is why the bottom soil is always more moist than the surface soil. Slowly the water from the lower surface begins to creep up around the soil particles, just

as the oil creeps up a lamp wick, or as ink moves up a piece of blotting paper. Each particle, however, will continue to be covered with a film of water and when this reaches its thinnest stage, upward movement ceases. When roots take water from the soil, the films of water in contact with the roots get thinner, and this causes a movement of water toward the roots, just as in the case of evaporation, there occurred a movement toward the upper soil particles. We call the force which brings about this movement of water capillary attraction.

Take two glasses, fill one with water, and place them side by side. Place one end of a lamp wick in the glass contain-

ing the water, as shown in sketch, and let the other end hang into the empty glass. Watch the results.

Increasing Upward Movement of Water.—It is possible to increase the upward movement of the water in soils and to draw up water from the subsoil by keeping the soil particles fine and close together. Naturally, then, in a well prepared seed bed there would be more



APPARATUS TO TEST THE POWER OF SOILS TO TAKE UP MOISTURE FROM BELOW.—*Farmers' Bulletin No. 408, United States Department of Agriculture.*

water near the surface than in a seed bed which is not well prepared, but cloddy and loose. The upward movement of water may also be illustrated with lamp chimneys, as shown in the sketch.

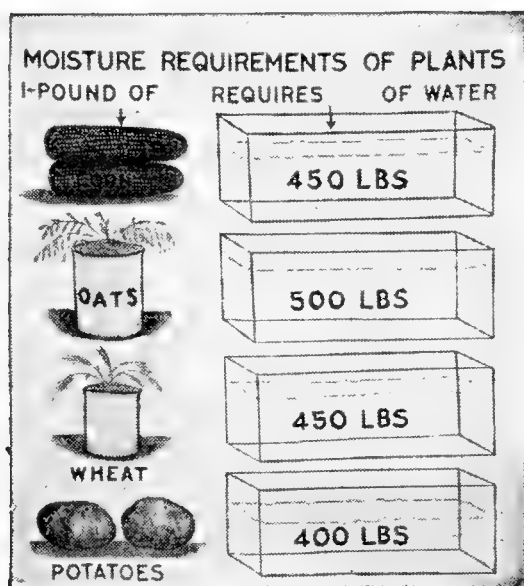
To the bottom of three lamp chimneys securely tie a piece of cheese cloth. Fill one chimney with gravel, one with sifted sand, and one with any fine soil. Set the bottom of each chimney in a glass of water and watch for the results.

You probably have noticed that in a garden which has just been spaded and raked, the soil under your footsteps looks more moist than that in other places. If a

soil is well prepared, and slightly compact, the water rises readily and much will be lost by evaporation unless the process of evaporation is checked.

26. Checking Evaporation.—The evaporation can be checked by loosening the particles of soil near the surface. This loosening breaks up the tubes, separates the particles, and prevents the film water of the lower particles from pressing too tightly together, or from coming into too close contact with one another. In this way, the movement of evaporation is greatly checked, and this explains why cultivation checks evaporation and helps to keep moisture in the soil.

27. Amount of Water Used by Plants.—The



Courtesy of Soil Improvement Committee of the National Fertilizer Association.

amount of water which plants contain, even when apparently dry, varies greatly. To keep healthy and secure enough raw food material from the soil, a plant must continuously have a great quantity of water passing through its stems and branches to the leaves. The greater part of this water, when it has reached

the leaves, evaporates from them into the air. Experiments have shown that, for each pound of dry grain to be harvested, from three hundred to five hundred pounds of water pass through the plants producing the grain.

28. Effects of Too Little Water.—When plants

do not receive enough water they stop growing, or grow very little. This is both because water is a raw food material and because it carries to the leaves the other raw food materials which the plant gets from the soil. When a plant does not receive enough water, it partly closes its breathing pores so that less water evaporates. But if the amount of water still given off by the leaves is so much that not enough is left to keep the plant stiff and rigid, the leaves, and the other green and tender parts wilt.

A leaf is very much like a little toy balloon; as long as the balloon contains enough air, it is round and smooth, but, when it does not contain enough air, it loses its shape and shrivels. In just the same way, a leaf stays firm and in shape as long as it contains enough water, but as soon as it holds too little water, it begins to wilt and droop.

29. Effects of Too Much Water.—Plants may suffer from too much water in the soil as well as from too little. If it rains so hard that water stands for some time in a cultivated field, where corn, clover, or grains are growing, you know that the plants will die. We commonly say they are drowned out. You see, the soil has become so wet that the water fills all the spaces among the soil particles, and there is no room for the air. Good soils must have air in them. The roots of plants need air and so do the good bacteria which are needed in the soil.

30. Effects of Water on the Development of Roots.—The roots of plants will not grow down into any free water in the soil. When plants find the

ground too wet, the roots stop growing down and begin to spread out near the surface. This develops a shallow root system and crowds all the roots near the surface. Later, when the weather gets hot and dry, the top soil dries out rapidly and the roots being near the surface, dry up, because they cannot then grow down quickly enough to reach the moisture deeper in the soil. It sometimes occurs that when land is tile drained the crops dry out. In such a case one would naturally conclude that the tile removed too much water, but this is generally not so. On the contrary, drying out is due to the fact that the tile did not remove enough water, soon enough. Thus a shallow root development occurred. Had the roots gone down deeper earlier in the season, the crops would not have dried up.

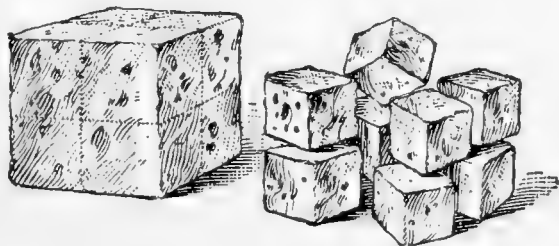
31. Wet Soils are Cold and Sour.—A soil that is very wet is cold. There are two principal reasons for this; the warmer air cannot enter the soil, and also, large amounts of water are evaporating from the surface. Evaporation of a liquid takes away heat. Wet soils are generally sour or acid because there is little opportunity for the acid to drain off.

32. The Amount of Water Held by Soils.—The amount of water held by soils depends upon the size of the soil particles and the amount of humus the soils contain.

Sandy soils	hold	about	15	per	cent	water
Loam	"	"	25	"	"	"
Clay	"	"	30	"	"	"
Marsh	"	"	150	"	"	"

This means that 100 pounds of an average, air dried, sandy soil will hold about 15 pounds of water when water is added to it, and 100 pounds of a loam soil, about 25 pounds, and so on.

33. How the Soil can be Made to Hold More Water.—Humus acts like a sponge in holding water. It not only soaks up water but at the same time covers itself with water. By soaking up, we here mean that water enters into the material. The mineral soil particles take no water into the inside of themselves. The water they retain as we have already seen, is found only in the form of a film on the outer surface of the soil particles. If



EXPERIMENT SHOWING INCREASE OF
SURFACE BY SUBDIVISION

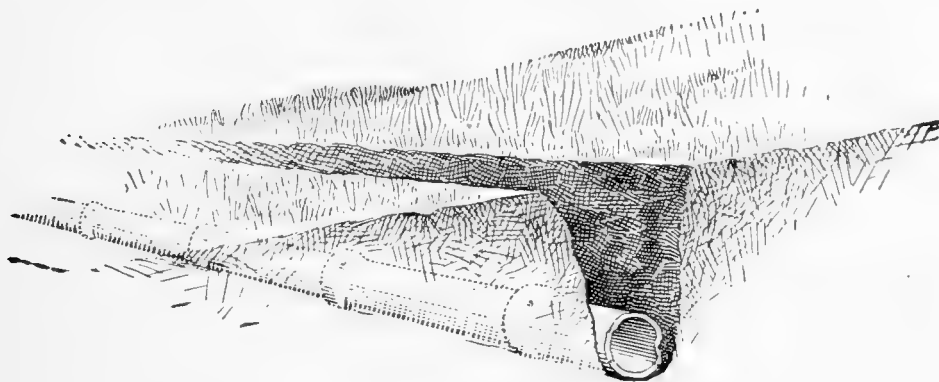
we take a stone one inch in diameter and break it up into one thousand pieces, and then compare the surface area of all the pieces with that of the original stone, we shall find that the sum of the surface area of all these pieces, is very much larger than that of the original stone. Therefore the amount of film water held by all the pieces would be very much greater than that held by the stone. Now let us take an illustration of this. A cube of cheese one inch square has an area of six square inches. By three cuts with a knife, the inch cube can be made into eight half-inch cubes. The surfaces of these eight cubes together is now twelve square inches or twice that of the inch cube. Furthermore, the inch cube offered no space into which a liquid could be poured, but the eight smaller cubes thrown together offer many little spaces.

34. Humus and Water Holding Capacity.—It has been estimated (Farmer's Bulletin 245), that one ton of humus will absorb two tons of water and give it up readily to growing crops. This would make its water capacity 200 per cent. Therefore, we readily conclude that as the amount of humus in a soil increases, the water holding capacity of the soil increases. This shows us again the great value of manure, straw, sod, and in fact, all forms of organic matter, in the soil, and makes us realize why an effort should always be made to return them to the soil instead of permitting such materials to decay in piles, or to be burned, or otherwise neglected.

35. The Benefits of Underdrainage.—When in any soil free water is inclined to accumulate near the surface, so as to interfere with the downward development of the roots, drainage is necessary. There are many reasons why soils often contain too much water. The land may be too low or too flat. The nature of the subsoil may be such that it does not allow the free water to pass away quickly enough. Or there may be too much seepage from some higher land near by. Underdrainage is absolutely necessary to remove this excess of free water. When the free water, which in wet soils is cold, stale, and foul, and often acid, is carried off, there will be more room for air in the soil, the roots will grow deeper, and the soil will be warmer. Especially in the spring do we need warm air in the soil to allow early preparation of the seed bed to hurry the growth of young plants, and to hasten the making of the raw plant food they need.

36. Methods of Drainage.— There are four common methods used in draining land: the surface drains, which are generally open ditches; tile drains; vertical drains; and dynamiting the subsoil.

Tile Drains.— One of the most satisfactory ways of draining land is with tile. The tiles are generally one foot long and vary in diameter, four inches being the smallest diameter commonly recommended. These tiles are laid in a ditch which is three or more feet deep, ac-



A TILE DRAIN

ording to the soil condition. The tiles are placed end to end, without cementing, on a uniform grade of two or more inches per hundred feet, and the trench or ditch in which they are laid is filled with earth. The free water from the soil gets into the tiles through the small spaces where the ends join one another and flows through the pipes of hollow tiling. The rows of tile are placed through the field at distances apart varying from three to eight rods, according to the character of the soil. They are put closer together in heavy soils than they are in light.

Surface Drains.— Farmers sometimes drain their land by open ditches, but it is hard to work a field cut

up in this way. When it is necessary to have such ditches, it is best, if possible, to make them so broad and so gently sloping as to permit them to be planted to grass and to be mowed readily with a mower.

37. Irrigation.—By irrigation we mean the addition of water to soil which does not get enough from the rainfall. Large areas of land, amounting to millions of acres, which naturally do not receive enough rainfall, have by means of irrigation been brought into cultivation. Irrigation mostly is confined to arid and semi-arid regions. On a small scale, it is, however, also practical in some of our southern states where the summers tend to be too dry. Some of our richest and most valuable soils are found in irrigated regions, land which, without irrigation, would be useless. All our large irrigation projects are found in the western states.

38. Sources of Water.—The most common source of water for irrigation is rivers. These are dammed quite frequently in a number of places, so as to make large storage reservoirs which hold back the fall, winter, and early spring water when it is not needed. From these reservoirs, canals carry the water to be distributed, by means of smaller canals, over the land. Generally the amount of water allowed each farmer in an irrigated section is limited, and this limit checks all waste and insures the most economical use. Thus in the height of the growing season, when much water is needed, it is available. Small projects often are irrigated by means of pumps. That is, the water is pumped from a river or from wells into canals, to be distributed. In like

manner artesian wells also are used for irrigation. Although there are many disadvantages to irrigation, there is one great advantage and that is that the crops can be watered when they need the water most. Two to four irrigations a season are generally enough to produce most of our common crops.

QUESTIONS AND PROBLEMS

1. If an inch cube were cut into 64 equal cubes, how many cuts would you have to make, how much surface would be added by each cut, and how would the final surface compare with the original surface?

2. Give illustrations of capillary attraction not mentioned in the book.

3. Which would be better, to water a lawn or garden a little and do it often, or give it a thorough soaking once in a while? Why?

4. Would you pick lettuce early in the morning or in the middle of the forenoon? Why?

5. Can every piece of land be drained? What conditions are necessary in order that it may be drained?

6. If the wheat plant uses 450 lbs. of water to produce one pound of dry matter, how many tons of water per acre would be required to produce a crop of 30 bu. of wheat to the acre?

7. If one inch of water over an acre weighs nearly 100 tons, what is the weight of the annual rainfall per acre in your locality?

8. Why does draining the soil enable a farmer to work it earlier in the spring?

9. Why will plants on well drained land stand a drought better than plants on poorly drained land?

38 AN INTRODUCTION TO AGRICULTURE

Bulletins for Sale by Superintendent of Documents, Washington, D. C.

Studies on Movement of Soil Moisture, Soils Bulletin 38, 10 cents.

Mechanics of Soil Moisture, Soils Bulletin 10, 5 cents.

Moisture Content and Physical Condition of Soils, Soils Bulletin 50, 15 cents.

Water Requirements of Plants, B. P. I. Bul. 284, 15 cents.

Methods of Applying Water to Crops, Yearbook, Sept., 514, 5 cents.

Agricultural Duty of Water, Bulletin 526, 5 cents.

Farmers' Bulletins.

Management of Semi-arid Soils to Conserve Moisture, F. B. 266.

Tile Drainage on the Farm, F. B. 524.

Drainage of Farm Lands, F. B., 187.

Practical Information for Beginners in Irrigation, F. B. 864.

Farm Reservoirs, F. B. 828.

Irrigation of Orchards, F. B. 882.

Surface Irrigation for Eastern Farms, F. B. 899.

CHAPTER V

TILLAGE

“Tillage is manure.”

39. The Ideal Condition of the Soil.— If a seed is to germinate readily it needs air, warmth and moisture; and if a plant is to thrive, and have a vigorous root development, it needs a mellow, slightly firmed seed bed. Such a seed bed is in a good *physical condition* or is in *good tilth*. Good tillage, proper drainage, organic matter, and lime have much to do with the tilth of a soil.

40. Objects of Tillage.— The term tillage generally covers all those operations used in fitting the soil for the seed, and in caring for the growth of the crop. The principal reasons for the tillage are: to provide a good home or growing place for the crop; to conserve moisture; to liberate raw food materials; and to destroy weeds. The better the physical condition, the greater is the water capacity of any particular soil, the more is evaporation reduced, and the more satisfactory is the capillary movement. Earth brought to the surface from a depth of a few feet is not very productive until it has been exposed to the weather for some time. Such earth needs the action of the air, sunlight, etc., to make it productive. To some extent, the same is true of our

upper soil in the fields. Weeds must be destroyed promptly, as they not only occupy space which belongs to the crop but they also rob the soil of moisture and of raw food materials which should go to the crop.

41. The Preparation of the Seed Bed.—*Plowing.*
— Generally the first important work necessary in the preparation of a good seed-bed is plowing. Thorough plowing is essential, and if this work is poorly done the benefits of all the other operations will be greatly lessened. Good plowing is just as essential as good soil and good seeds, and unless plowing is done in the best manner and at the right time, the best results cannot be obtained. The pride of every plowman is a straight, well-turned furrow. Its true merit is measured by its depth, the manner in which it is turned, and the way in which it lies. When properly turned, it will present a loosely pulverized furrow-slice which completely covers all the vegetation which was on the surface. If the land is plowed while it is too wet or too dry, not only is good plowing impossible, but the soil even may be ruined for at least a year. When land, which is not going to be put into crop until the following spring, is plowed in the fall, the complete pulverizing of the furrow-slice is not so important, because the lumps and clods will crumble and pulverize under the action of the weather.

Mixing the Soil with Vegetable Matter.— Land which is heavily manured, or which contains much vegetable matter, such as a green manure or a sod, is benefited by being disked before it is plowed, so that the organic matter may be mixed thoroughly with the soil. In-

jurious effects often result when too much organic matter, which has not been thoroughly mixed with the soil, is plowed under. This organic matter is likely to form a layer between the furrow-slice and the soil directly



A GANG PLOW.— *Courtesy of the Janesville Machine Co., Janesville, Wis.*

beneath it, which may prevent the capillary rise of water. This fact may be demonstrated easily with the lamp chimney used in the experiment to illustrate the rise of water.

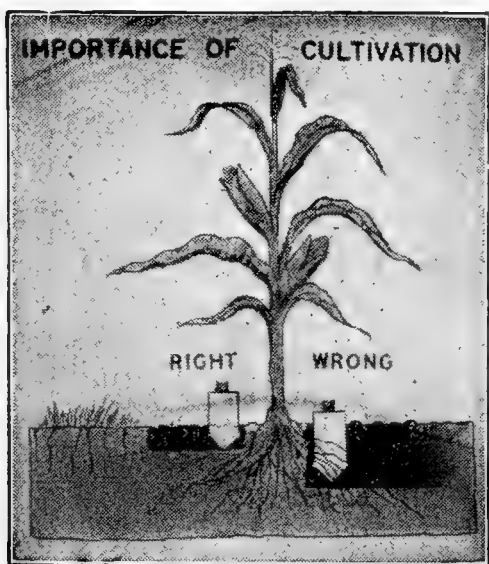
Half fill the lamp chimney with fine sand or any dry soil. Add to this lawn clippings or chopped hay to make a layer about an inch thick, and then fill the remaining space in the chimney with the soil material. Now set the bottom in water, as you did in experiment before, and note the results.

Disking.— Disking is especially useful in pulverizing plowed sod land, and in loosening any crusted condition of the surface of a field which has lain for some time after it has been plowed, or on which many small weeds

have started to grow. A disk does work a harrow cannot do.

Harrowing.— The harrow generally follows the plow. There is scarcely a crop grown which does not need the use of the harrow in the preparation of its seed bed. The harrow both levels and fines the topmost layer of soil, and also creates an excellent dust mulch for preventing the loss of soil moisture. The harrow is also the most practical implement used for destroying weeds while they are still small.

42. Cultivation.— Grains and cultivated crops are sometimes harrowed to loosen a crusted condition of the surface soil and to destroy small weeds. This harrow-



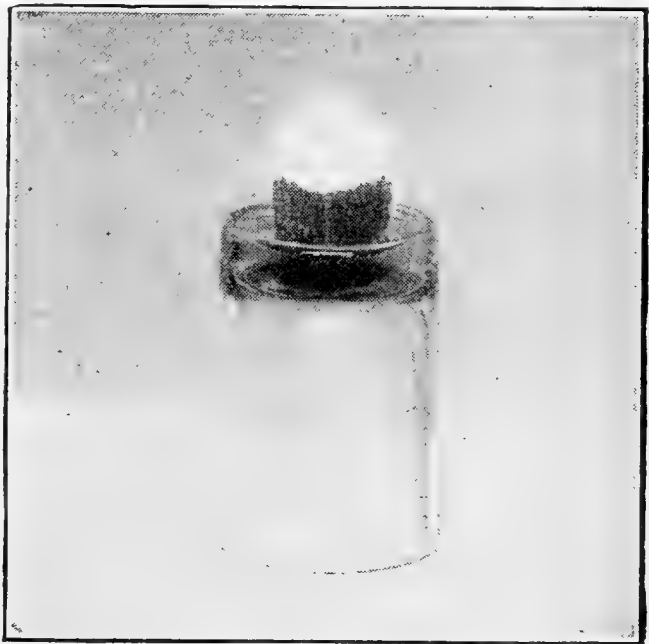
Courtesy of the Soil Improvement Committee of the National Fertilizer Association.

ing must be done lightly and at a time when the growing crop will be least damaged. The weeder finds its principal use in this operation. Intertillage, or cultivation between the rows, loosens the surface soil to admit air, to help set free raw plant food, to conserve water, and to destroy weeds. Early cultivation should permit a farmer to get close to plants without injur-

ing them. It is necessary that this cultivation leave the soil in a fine condition, so that the tiny roots are neither injured by the rapid evaporation of moisture, nor left uncovered by the soil. As the crop grows, the cultivator may be allowed to throw a small amount of soil around

the plants, but the old practice of *hilling up* the crops is very objectionable. This is an “out of date” practice which not only does no good, but inflicts injury by causing rapid evaporation of soil moisture through exposing roots, and often by cutting all the roots near the surface. Shallow level cultivation with just a slight working of the soil toward the plants, should be the rule. Two inches is generally deep enough. Cultivation should be frequent, weeds should be destroyed while small, and the surface of the soil should be kept loose. After every rain, when the physical condition of the soil is right, the soil should be cultivated to conserve as much water as possible.

43. The Dust Mulch.—We have already spoken a number of times about a dust mulch. Now let us try to get a clear picture of how it is possible for this dust mulch to check the evaporation of moisture from the soil. If we put a piece of lump sugar into a saucer containing a little water colored with a few drops of ink, we shall notice that the colored water rises rapidly to the top surface.



THE CUBE FIVE SECONDS AFTERWARD.—
Courtesy of the International Harvester Company.

This illustrates the capillary rise of water. If we take another lump of sugar and drop upon it a “heaping

pile," all it can hold, of powdered sugar, and place this covered lump in the saucer of water we shall notice that the colored water reaches only the lowest portion of the powdered sugar and stops there.



MOISTURE WILL NOT PASS OUT THROUGH THE POWDERED SUGAR.—*Courtesy of the International Harvester Company.*

Why does not the liquid continue to rise to the top? The particles of powdered sugar are so dry, light, and small that they hardly touch each other and the spaces between them are rather large. It is difficult, under these conditions, for capillary water to rise from one particle

to another. In just this way a dust mulch, created on the soil by constant cultivation, protects the soil against too rapid evaporation of water.

44. Dry Land Farming.—In regions where the amount of rainfall is not sufficient to raise a profitable crop and where irrigation is too expensive or impossible, "dry farming" has been put to use.

The aim of this special method of tillage is to save what little rainfall there is, by continually stirring the ground and keeping, on the surface, a dust mulch to check evaporation as much as possible. Sometimes the land is tilled for a whole year at a time in order to store up sufficient moisture for a crop to be grown the follow-

ing year. This method gives but one crop in two years. In regions where there is slightly more rainfall, two crops are often grown in three years; and in some localities dry farming permits a crop in every year; but in each case the same principles are applied. Farmers are now producing good crops by dry farming, with only ten, twelve, or fifteen inches of rainfall annually. Dry farming is practiced in many of the Western and Southern states; and practically in all farming sections where occasional periods of drought are apt to occur. If, during a dry spell, you cultivate or rake your garden early each morning to keep a light dust mulch constantly on the surface, you are really putting "dry farming" principles into operation. These principles consist in checking evaporation and in destroying all weeds so that no soil water may be wasted.

QUESTIONS AND PROBLEMS

1. How may any one who has a garden apply the lessons of dry farming?
2. Describe how you have seen a seed bed prepared.
3. Can you give any instances where better tillage gave better results? Give them.
4. How many square feet are there in an acre? If a farmer plows eight inches deep, how many cubic feet does he move in plowing an acre?
5. If a cubic foot of soil weighs 80 lbs., what is the weight of an acre of soil 8 inches deep?
6. How many acres are there in a piece of land 32 rods long by 20 rods wide?
7. If land of that measurement is plowed back and forth with furrows nine inches wide, how many miles will a man travel in plowing it?

8. If by extra cultivation a man can raise 25 bushels of potatoes more an acre and he cultivates 6 acres a day, what is his gain, allowing \$4.00 per day for a day's work? Use the local market price of potatoes.

9. What attachments to plows do farmers in your community use?

Bulletins for Sale by Superintendent of Documents, Washington, D. C.

Traction Plowing, B. P. I., Bulletin 170, 5 cents.

Farmers' Bulletins.

Care and Repair of Farm Machinery, F. B. 946, 947.

CHAPTER VI

ELEMENTS OF PLANT FOOD IN THE SOIL

“ A fertile soil means a prosperous people.”

In this chapter we shall consider principally the question of the raw plant food materials which the plant secures from the soil.

45. Raw Plant Food Materials.— The raw food materials necessary to the growth of crops are usually spoken of as the *elements of plant food*. An element, according to chemistry, is a substance composed of only one kind of matter. There are about eighty distinct and different elements in the world. Most substances which we see around us are made up of several elements combined. Two or more elements combined make what is called a *compound*.

The elements on which a plant feeds enter the plants, not as elements, but united with other elements in the form of compounds. There are, in fact, ten different elements which are necessary for plants to have for food. These are:

- | | | |
|-------------|---------------|--------------|
| 1. Oxygen | 4. Nitrogen | 7. Calcium |
| 2. Hydrogen | 5. Phosphorus | 8. Magnesium |
| 3. Carbon | 6. Potassium | 9. Iron |
| | | 10. Sulphur |

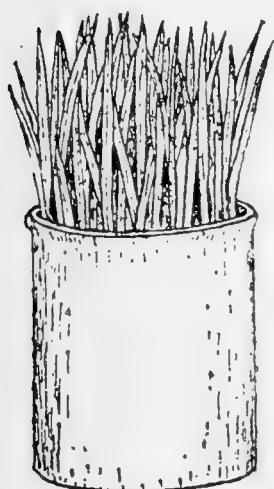
Oxygen.—Oxygen is a gas that forms a part of air and water. It forms about one-fifth of the volume of the air. Whenever anything burns, you may know that oxygen is present, for nothing can burn without oxygen. Plants get their supply of oxygen, which they need for food, from the air and from water. Water is a compound of hydrogen and oxygen, and this water is taken into the plant only from the soil by means of the root hairs. If there is plenty of water, the supply of oxygen which a plant requires for raw food need not worry the farmer.

Hydrogen.—Hydrogen is a gas obtained from water. It is the lightest gas known and it burns with a nearly colorless and hot flame. A plant gets the hydrogen it needs from water in the soil by means of its root hairs.

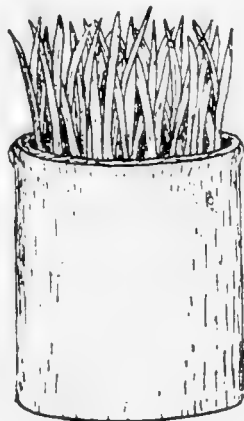
Carbon.—Carbon exists commonly as charcoal. The black substance on the end of a burned match is carbon. Wood and coal contain carbon, and when they are burned the carbon escapes into the air in the form of a colorless gas. The carbon combines with oxygen and forms the compound called carbon dioxide, or carbonic-acid gas. The breath from our lungs contains carbon dioxide, as you have learned in your study of physiology. Man and beast do not use the carbon dioxide in the air, but plants are constantly taking it in through the pores in the leaves, and use it as one of the raw food materials.

Nitrogen, Phosphorus, and Potassium.—Three of the most important elements of plant food are nitrogen, phosphorus, and potassium. These elements the plant gets from the soil; for they, in their various compounds,

make up the most important part of the mineral matter which the plant takes from the soil. Plants need a considerable amount of these elements and in many soils there is not nearly enough of them. Commercial fertilizers are often used to supply this need, and the price of any fertilizer depends upon the amount of these three elements it contains. There are, however, as we shall soon see, other ways besides the use of commercial ferti-



NITROGEN



PHOSPHORUS



POTASSIUM

POT CULTURE

In the above jars, nitrogen is evidently the plant food needed most.—
Courtesy of the Iowa State Department of Public Instruction

lizers, to supply these three important raw plant foods to the soil.

Nitrogen.—Nitrogen is a gas. It forms four-fifths of the air we breathe, the other part being mostly oxygen. The plant gets all its nitrogen through its roots in the form of a soluble compound called a *nitrate*. There are two sources of nitrogen in the soil. The principal one is the organic matter which the soil contains. The other is the air in the soil. The compound of nitrogen,

called a nitrate, which the roots of a plant take up, is made in the soil by the good bacteria, from the organic matter and from the nitrogen in the soil air.

Legumes are always rich in nitrogen. When they decay in the soil, the nitrogen they contain is left in a form which is readily changed back into a nitrate. This is partly the reason why crops like clover and alfalfa have such a good influence upon crops which follow them in a field. Nitrogen is the most expensive element of plant food, and there is no cheaper way to supply it than by growing legumes. Since nearly all the nitrogen found in the soil is combined with other elements in the organic matter or humus, it is very easy to see that the soil which is rich in humus is the one which is also rich in nitrogen. On the other hand, a soil which is poor in humus, is also poor in nitrogen. Besides growing legumes, another common way to add nitrogen to a soil, is to put manure, nitrate of soda, or other fertilizers containing nitrogen upon it.

Phosphorus.— You have all heard of phosphorus, for it is commonly used in the making of matches. It is a scarcer element than nitrogen, though more familiar to us. A plant gets phosphorus, as it does nitrogen, from the soil. When the supply of phosphorus in a soil is once used up, there is no way of supplying this element again except by adding to the soil some substance containing phosphorus. The element phosphorus ¹ is never

¹ Because phosphorus is never found free in the soil or in crops but always combined, it is common in some states, to speak not of the actual amount of phosphorus in the soil or crops, but of the amount of phosphoric oxide, called “phosphoric acid.” To change the amount of phosphorus to an approximate amount of “phos-

found free in the soil, because it is very active and readily unites with oxygen;— that is, it takes fire easily. You see this fact illustrated every time you strike a match. The tip of a match contains a compound of phosphorus and when it is rubbed or scratched, the phosphorus unites with the oxygen of the air and begins to burn, thus setting fire to the match. The root hairs absorb the phosphorus in the form of a soluble compound, called a phosphate. The most common materials which can be added to a soil to increase its amount of phosphorus are manure, ground bones, ground phosphate rock, and a substance called acid phosphate, made from ground phosphate rock and ground bones.

Potassium.— Potassium is a silvery white metal, soft as wax, and light enough to float on water. It is very active and unites so readily with oxygen that it has to be kept in air-tight bottles or under kerosene to prevent it coming in contact with oxygen or water. Naturally then we cannot expect to find any free potassium in the soil. A plant gets all its potassium in the form of compounds dissolved in the soil water. The mineral feldspar found in granite rocks is the chief source of potassium in the soil. When the supply of potassium in the soil is once used up, there is no way to replenish it except by adding substances which contain it. The commonest substances added to soils to increase the amount of potassium are wood ashes, manure, and certain other fertilizers which contain potassium. It is common in

phoric acid ” we need only to multiply the amount of phosphorus by 2.3. When the amount of “ phosphoric acid ” is divided by 2.3, we get the approximate equivalent amount of phosphorus.

many places to speak of the amount of “potash” contained in soils and in crops instead of the amount of potassium. “Potash” is a compound of potassium and oxygen.¹

Other Plant Foods.— Besides the six principal plant foods just described, a plant also needs the minerals, calcium, magnesium, iron and sulphur. Most soils contain the iron and sulphur they need and the root hairs of plants take up these elements dissolved in the form of compounds in the soil water. Many soils, however, are lacking in calcium and magnesium. Calcium makes up a large part of limestone and of all other forms of lime. Although calcium is a plant food, it is not so much needed in the soil for food as for keeping the soil sweet. Magnesium, too, is needed both for a plant food and for sweetening soils. Neither of these elements, calcium and magnesium, is ever found by itself, in a free state, but is always combined with other elements in the form of compounds.

46. Amount of Raw Plant Food in Soils.— Soils differ very much in the quantity of raw plant food which they contain. When the amount of raw plant food in a soil is being estimated, only the really important raw food in a soil is usually considered, that is, the nitrogen, phosphorus and potassium. The quantity of this is sometimes expressed in pounds, and sometimes in its per cent. of the whole weight of the soil which is being considered. Generally this is the top seven

¹ The amount of potassium multiplied by 1.2 gives the approximate amount of potash; and the amount of potash divided by 1.2 gives the approximate amount of potassium.

inches of a soil, because that is the part which forms the plow land. According to the usual estimation, an acre of ordinary loam soil, about seven inches deep, weighs about 2,000,000 pounds. When an acre of soil contains about 4000 pounds of nitrogen, 2000 pounds of phosphorus and 25,000 pounds of potassium, it is well supplied with the important elements of raw plant food. Soil surveys state the amount of raw plant food in the common soils of a community.

47. Available Plant Food.—Most of the raw plant food is in the soil in very much the same way that a stone would be in a glass of water. That is, the stone is in the water but it is not a part of the water. In other words the stone is not soluble in the water. In just the same way most of the raw plant food found in the soil is not soluble, and therefore is not in a condition to be used by plants for food. This is really a very good thing, because if all the raw food material dissolved readily in the soil water, the rains would wash it all out, and in a very short time there would be none left in the soil. That part of the raw plant food materials which through the action of the air, acids, soil water, and bacteria, becomes dissolved in the soil water just as sugar dissolves in water, may be taken up as food by plants through their root hairs. Such raw plant food is called *available*. But that part of the raw food materials which remains in the soil water, just as sand does in water, cannot be taken up as food by plants, and is called *unavailable*.

48. How the Elements of Plant Food Get into the Plant.—The raw food materials in the soil must be dis-

solved in water. When the root hairs come in contact with this water, some of it passes through their delicate wall by a process called *osmosis*. As fast as the root hairs make use of this raw food, more of it is absorbed by the root hairs and thus the process continues. Inside of each root hair is a liquid-like substance called *protoplasm*, which is the living part of the plant. This protoplasm in the root hairs, not only draws in the soil solution but also passes it on to neighboring parts, and this action continues until the soil solution reaches the leaves. Thus by a constantly moving current the raw food materials are conducted up to the leaves, to be changed into nutrients so that all the tissues of the plant may be nourished.

Put a slice of a raw potato, about one-fourth of an inch thick, into a glass containing a strong salt solution. Put another similar slice into a glass of plain water. After a day remove each and notice the difference.

QUESTIONS AND PROBLEMS

1. Name four kinds of plants that are raised primarily for their leaves or stalks.
2. What commercial fertilizers are used in your community and what elements of plant food do they supply?
3. Give a list of substances containing considerable carbon.
4. What common substances are there which are chiefly carbon?
5. Have you ever seen any phosphorus? Have you ever used anything that contained phosphorus?
6. Mention one of the most common substances containing potassium.
7. Have you ever seen magnesium powder burned to make a flashlight for taking a photograph?

8. Is it a good practice to rake leaves into the road and burn them?

Bulletins for Sale by Superintendent of Documents, Washington, D. C.

Minerals Composition of Soil Particles, Soils Bul. 54, 10 cents.

Nitrogenous Soil Constituents, Soils Bul. 87, 15 cents.

Phosphoric Acid, Bul. 143, 5 cents.

Results of Investigations on Rothamsted Soils, Exp. Sta. Bul. 106, 10 cents.

Nitrogenous Fertilizers Obtainable in U. S., Soil Bul. 37, 5 cents.

The Recovery of Potash as a By-Product in the Cement Industry, Dept. Bulletin 572, 5 cents.

CHAPTER VII

SOIL FERTILITY

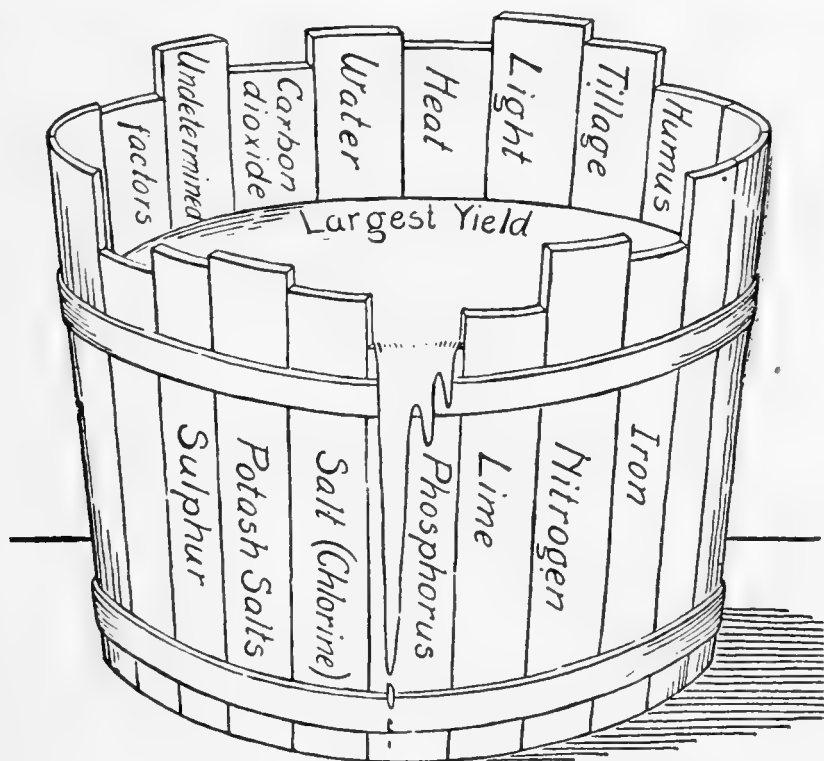
“It is not the land itself that constitutes the farmer’s wealth, but it is in the constituents of the soil, which serve for the nutrition of plants, that this wealth truly consists.”—*Liebig*.

49. How Soils Become Unfertile.—Whenever a soil is constantly cropped, and little or nothing is returned to it, to keep up its supply of raw plant food, that soil slowly and gradually changes, becoming less productive. Constant cropping tends to decrease the amount of humus, the amount of the elements of plant food, and the amount of lime, in the soil; and it also tends to destroy the good physical condition of the soil.

Changes in Physical Condition.—When lime and humus in a soil are destroyed, and when soil acids accumulate, the physical condition of the soil changes. If you compare some good soil with some poor soil you can easily see what the changes have been. The poor soil is one which has lost its light, crumbly condition. It packs easily, especially if it is a loam or clay soil. Its color, also, has become lighter and its power to hold water less. It is less favorable to the growth of soil bacteria and in it less plant food is made available.

Elements of Plant Food Removed by Crops.—Table 2 in the Appendix shows the average amount of the

three essential elements of plant food in the various crops. If one knows the weight of the crop harvested from an acre of land, he can, from this table, determine approximately the amounts of these elements removed from an acre. It has been calculated that a ton of timothy hay removes from the soil about 18.8 lbs. of nitrogen; 2.8 lbs. of phosphorus, and 23.6 lbs. of potas-



A SOIL FERTILITY BARREL

The water level can rise no higher than the lowest stave. The fertility of the soil is limited by the lowest amounts of its most indispensable elements.—*From Wisconsin Bulletin 265.*

sium; and 50 bushels of oats and $11\frac{1}{2}$ tons of oat straw remove 26.6 lbs. of nitrogen; 6 lbs. of phosphorus, and 67.6 lbs. of potassium. These figures are here given merely to show that no two crops use the elements of plant food in similar amounts or in similar proportions.

50. The Use to a Plant of the Elements of Plant Food.—*Potassium.*—Most of the potassium goes into

the straw and stalks of the plants. It strengthens and stiffens these parts. Weak stalks and weak stems in common farm crops are an indication that not enough potassium is available. Besides strengthening and stiffening plants, an ample supply of potassium hastens the maturing of plants.

Phosphorus.—Much of the phosphorus found in plants is in their seeds. Phosphorus helps to fill out the seeds and make them plump. Some of the phosphorus in the grain is discarded in the bran when flour is made, and for this reason white flour is not so complete a food for man as whole wheat flour. Phosphorus also causes plants to ripen more quickly. When the conditions for plant growth are favorable, the occurrence of small, shriveled grains is an indication that there has not been enough available phosphorus for the plant.

Nitrogen.—The greater part of the nitrogen is also found in the seed. An abundant supply of nitrogen also results in the production of large, healthy leaves and stalks. Hence nitrogen is especially valuable for the plants which are raised for their leaves and stems, such as hay, asparagus, and lettuce. Too much nitrogen in a soil tends to retard maturity.

51. Evidence of Lack of Plant Food.—A lack of any of these elements, potassium, phosphorus, and nitrogen, will greatly lessen a crop. Whenever a crop is increased by adding to the soil a material containing any of these elements in an easily available form, you may know that the soil itself is failing to furnish enough of that particular element of plant food.

52. Fertilizers.—An important question for every farmer to consider is how he is going to provide the plant food needed by his growing crops. Often he has to do this by adding to the soil some substance containing one or more of the three essential elements of plant food, phosphorus, potassium, and nitrogen. Any substance so added is called a *fertilizer*. There



University of Illinois Circular 168

LAND TREATED WITH MANURE, LIMESTONE AND A PHOSPHATE FERTILIZER

are two classes of fertilizers, the natural and the artificial or commercial. Natural fertilizing products such as manure, weeds, and crop residues like roots, straw, stalks, and leaves, are examples of *natural fertilizers*. Manufactured fertilizing products such as nitrate of soda and bone meal, which are prepared and sold in the commercial market, are examples of *commercial fertilizers*.

53. Manure.—Close at hand for every farmer is a most valuable source of plant food. Barnyard manure contains all of the three essential elements of plant food. The average composition of farm manure compiled from many analyses is approximately as follows: Water 75% and organic matter 25%. One ton of manure will contain on an average 10 lbs. of nitro-



University of Illinois Circular 168

LAND TREATED WITH MANURE ONLY

gen, 3 lbs. of phosphorus, 8 lbs. of potassium, and about 500 lbs. of organic matter. The remainder will be mostly water. This analysis, however, will vary greatly according to the kind of animals from which the manure comes, the amount and kind of bedding used, the feed fed to the animals, and the manner in which the manure has been kept. Much of the value is often wasted by the slipshod way in which many

farmers take care of the manure. Manure which has been “fired” or been exposed to rain has lost much of its raw food materials. To preserve its full value, manure should be kept moist and compact, or else it should immediately be spread upon the land.

Value of Manure.—If the same amounts of raw plant food which are found in a ton of average farm manure were purchased in the form of commercial fertilizers, they would cost between two and three dollars. The organic matter which manure adds to a soil also has a little value which is not figured in the estimate just given. For in addition to the elements of plant food and the organic matter, manure contains enormous numbers of beneficial bacteria.

Manure Contains Little Phosphorus.—In spite of all its good ingredients manure is, however, very low in phosphorus. You can see this from the analysis already given. In most of our soils, too, phosphorus is the element of plant food most lacking. For these two reasons it is becoming a wise farm practice to add to manure, or to reinforce it, with some phosphorus fertilizer. Raw phosphate rock, very finely ground, is being widely used to reinforce manure and often used as an absorbent in the barn.

Amounts of Manure to Apply.—It is estimated that ten tons of manure applied to an acre of land once every four or five years is a fair application of manure for ordinary farming. It is not unusual, however, for a truck farmer to apply as much as twenty tons to one acre in one year. It has been repeatedly proven that manure put on the soil evenly and rather lightly

over a large area will give larger returns than manure applied irregularly and heavily over a small area. This is why a manure spreader should be used on all farms which have enough stock to justify the farmer in buying one.

If a farmer adds to his land ten tons of average manure per acre once in four years, he will be adding about 100 lbs., of nitrogen, 30 lbs. of phosphorus, and 80 lbs. of potassium. The question he should then ask himself is: Will this be sufficient to replenish the amount of these three elements removed by four years of cropping? It is safe to say that proper calculations on his part will show that there is much more raw plant food removed from the soil than there is returned to it. He now faces a new and serious problem, namely, how long with such a system of farm practice will his soil continue to be productive. This will depend on the amount of plant food in the soil. If our land is to remain productive, farmers everywhere must face and work out these problems. In making calculations like the one just suggested, it is customary to omit the amount of nitrogen removed by a legume such as clover, because the nitrogen which such a crop contains is said to come from the air.

Care of Manure.—The best method of handling manure is to haul it to the field day by day, as it is made. Unless manure is kept moist and compact and is preserved in such a manner that the liquid part of it cannot be washed away by rains, much of its value will be lost. Manure should never be allowed to lie exposed in piles for very long periods. All records

show that it loses in weight and in value rapidly if allowed to accumulate in large piles. Knowing how to properly care for manure and how to get the most value out of it is indeed an art for a farmer.

54. Crop Residues.— Whenever crop residues, such as stubble, corn stalks, sod, etc., are plowed into the soil, they decay rapidly and leave the elements of plant food in such a form that these elements become easily available for the succeeding crops. The roots of deep-rooted plants add considerable plant food to the surface soil, and thus some plant food, which ordinarily would be out of the reach of the roots of shallow-rooted crops, is put where these shallow roots can get it. Every one knows that a crop which follows clover, alfalfa, or some other legume is usually better than it is when the same crop follows a non-legume, such as corn or wheat. This improvement is partly due to the fact that stubble and roots of legumes contain more nitrogen than do the roots of non-legumes, and partly, also, to the fact that these legume residues decompose more readily and liberate the plant food more quickly than do the residues of non-legumes.

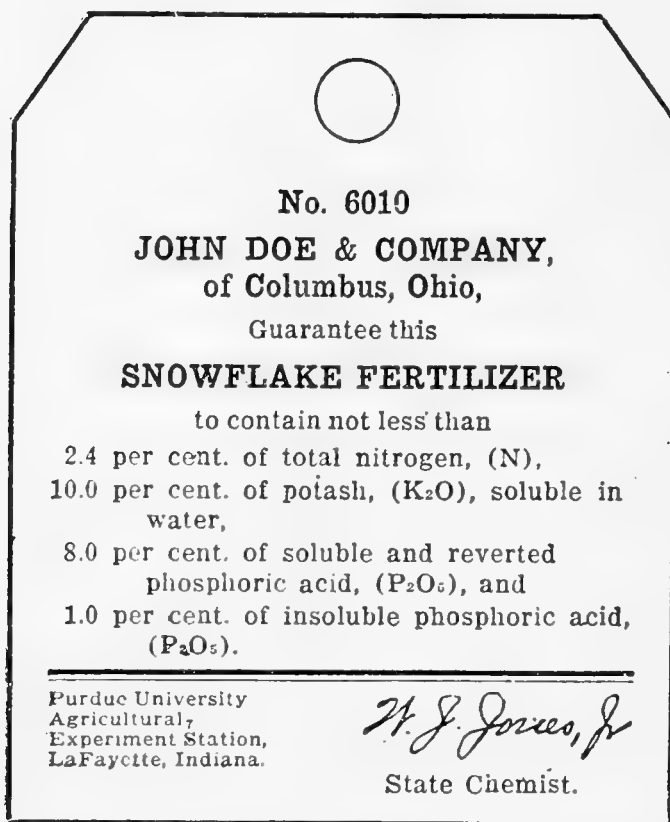
55. Commercial Fertilizers.— Commercial fertilizers are materials, prepared and sold in the market, containing nitrogen, phosphorus, and potassium, in a form suitable for use. These fertilizers are commonly sold by the ton in two hundred pound sacks. Many of them look like a coarse powder much like wood ashes. Others are much like salt in texture but are never as white and clean as salt.

If the school has samples of any commercial fertilizers

make a study of them. Note their color, texture, solubility in water and their reaction with litmus paper.

The value of any commercial fertilizer depends upon the amount and the solubility of the three essential elements it contains.

The price of commercial fertilizers varies greatly. During the European War the value of nitrogen and potassium became so high that it almost prohibited the use of these elements for agricultural purposes. Ordinarily 18 cents per pound is the average price of nitrogen in commercial fertilizers,



*Purdue University Agricultural Experiment
Station Bulletin 199*

that of phosphorus 8 cents and potassium 6 cents per pound, depending upon the materials from which they are made. A *mixed fertilizer* is one that contains two or all three of the essential elements. One containing all three of the elements is called a *complete fertilizer*.

56. Amounts of Raw Plant Food in Fertilizers.

— The amount of raw plant food contained in mixed fertilizers varies greatly. To indicate their composition to the buyer, fertilizers are called by numbers

which show the proportions of the three chief elements of plant food which they contain, as for instance, a 2-9-2 fertilizer or a 4-9-10 fertilizer. The numbers 2-8-2 (read two, eight, two), tell respectively the per cent. of available nitrogen or ammonia, "phosphoric acid," and potash found in such a fertilizer. The bags in which fertilizers are packed must bear printed statements of their composition.

The formula of commercial fertilizers generally gives the amount of ammonia, the amount of "phosphoric acid" and the amount of potash contained in them, and not the amount of nitrogen, phosphorus and potassium. However, to change the amounts of ammonia, "phosphoric acid" and potash to their equivalent amounts of nitrogen, phosphorus and potassium, use the following formula:

To change ammonia to nitrogen divide by 1.2.

" " "phosphoric acid" to phosphorus divided by 2.3.

" " potash to potassium divide by 1.2.

57. Fertilizer Laws.—Practically every state now has a law governing the sale of commercial fertilizers. These laws compel the manufacturers to print on each sack the following:

Per cent of nitrogen or ammonia.....
" " "available phosphoric acid.....
" " "total " ".....
" " "potash

The sum of the available and insoluble "phosphoric acid" equals the total amount of "phosphoric acid."

58. Use of Commercial Fertilizers.—There are

certain special crops, such as potatoes and tobacco, for which commercial fertilizers are extensively used. Truck farmers and market gardeners, also, make large use of them. You can readily see why this is so. These growers are raising crops which they want to grow quickly and yield heavily, and such crops demand much available raw plant food. This the growers can supply most promptly through the use of commercial fertilizers. Where it is known that soils are very deficient in phosphorus and potassium, maximum crop yields cannot be expected until these elements of plant food have been replenished in the soil. Commercial fertilizers can only produce the best results where the soil contains a good supply of organic matter and is not acid. The amount of commercial fertilizer to use varies greatly, depending upon the soil, the crop, and the grade of the fertilizer. In some instances, as when nitrate of soda is used for a top dressing, 150 pounds per acre is all that is used, while at the other extreme, truck farmers and potato growers often use as much as 2000 pounds, or a ton, of a complete fertilizer to an acre.

59. Mixing Fertilizers.¹— *A 2-8-2 Fertilizer.*— In a ton of 2-8-2 fertilizer there are 2% or 40 lbs. of available nitrogen or ammonia, 8% or 160 lbs. of available “phosphoric acid” and 2% or 40 lbs. of available potash. These materials are not found in the sacks of fertilizers as nitrogen, ammonia, “phosphoric acid,” and potash, but are in compounds which upon

¹ Table 3 in the Appendix gives the amount of plant food in common fertilizing materials.

decomposition, would yield them. A 2-8-2 fertilizer could be made as suggested below.

250	lbs.	of 16%	nitrate of soda	would yield 40 lbs. of nitro-
				gen.
1000	"	"	16% acid phosphate	would yield 160 lbs of
				"phosphoric acid."
80	"	"	50% chloride of potassium	would yield 40 lbs.
—				of potash.
1330	"	"	materials would furnish 240 lbs. of raw plant	
			food; and 670 lbs. of a so-called filler	
			would be added to make the ton.	

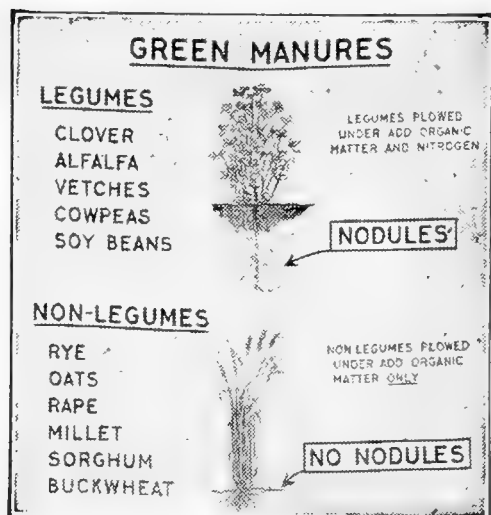
A 4-9-10 Fertilizer.— In this fertilizer let us assume that the first number of the formula refers to ammonia instead of nitrogen, then a ton would contain

4%	or	80	lbs.	of available ammonia
9%	or	180	"	" " " "phosphoric acid."
and 10%	or	180	"	" " " "potash

This fertilizer could be mixed as suggested below:

400	lbs.	of 20%	nitrate of soda	would yield 80 lbs. of am-
				monia
1100	"	"	16% acid phosphate	would yield 180 lbs. of
				"phos. acid."
400	"	"	50% chloride of potassium	would yield 200 lbs.
				of potash.
—				
1900	"	"	materials would furnish 460 lbs. of raw plant	
			food and only 100 lbs. of a "filler"	
			would be required. The 4-9-10 fertilizer	
			is commonly called a high grade fertilizer	
			because it contains little "filler;" the	
			2-8-2 fertilizer is an example of a low	
			grade fertilizer.	

60. Green Manuring.—Green manuring is the plowing under of green crops. Its main purpose is



Courtesy of the Soil Improvement Committee of the National Fertilizer Association.

to increase the amount of organic matter in the soil. Any green crop which makes a large growth in a short time and which will decay readily in the soil, is suited for green manuring. There is no quicker way to improve light, sandy, and gravelly, or heavy clay, soils than by increasing the amount of organic matter in them.

Leguminous plants are the most valuable for green manuring as they add considerable nitrogen to the soil.

61. Cover Crops.—Besides adding organic matter to the soil, green manure crops are often planted to cover the land during an idle period. Any winter crop, such as winter wheat, vetch, rye, or any winter green manure crop may be called a cover crop, as these protect the land from washing and blowing during the fall, winter and early spring.

QUESTIONS AND PROBLEMS

1. Would you consider manure or commercial fertilizers the best form of fertilizer for sandy soils?
2. Do farmers in your vicinity use any commercial fertilizers? What kinds?
3. Why is grain grown on the same field year after year apt to lodge?
4. Why are seeds valuable for food?

5. What are some of the different ways of caring for manure that you have seen?

6. Suggest some ways by means of which you could determine what particular elements of plant food might be lacking in a soil.

Bulletins for Sale by Superintendent of Public Documents,
Washington, D. C.

Fertility of Soils as Affected by Manures, Soil Bulletin 48,
10 cents.

Factors Influencing Soil Fertility, Soil Bulletin 40, 10 cents.

Crop Yields in Relation to Soil Fertility, Soil Bulletin 57, 20
cents.

Composition of Commercial Fertilizers, Soil Bulletin 58, 10
cents.

Fertilizers for Oats, Hay and Other Crops, Soil Bulletin 67,
10 cents.

Fertilizers for Potato Soils, Soil Bulletin 65, 5 cents.

Fertilizers from Industrial Wastes, Yearbook, Sep., 728, 5
cents.

Conservation of Fertilizer Materials from Minor Sources,
Yearbook, Sep., 733, 5 cents.

Phosphate Rock, Our Greatest Fertilizer Asset, Yearbook,
Sept., 730, 5 cents.

The Sources of Nitrogenous Fertilizers, Yearbook, Sep., 729,
5 cents.

Farmers' Bulletins.

Barneyard Manure, F. B. 192.

Commercial Fertilizers, Composition and Use, F. B. 44.

Use of Commercial Fertilizers in Southern States, F. B. 398.

Leguminous Crops for Green Manuring, F. B. 278.

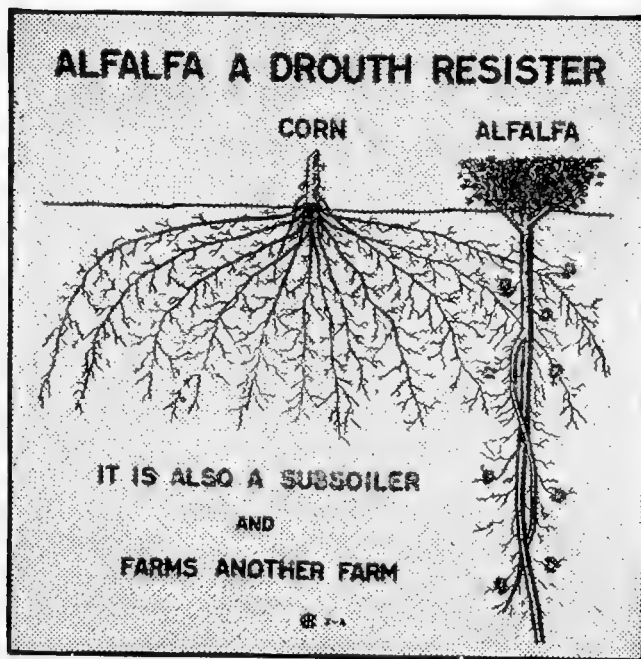
CHAPTER VIII

LEGUMINOUS CROPS AND ROTATION OF CROPS

“Phosphorus, lime, and plenty of clover
Will make the old farm bloom all over.”

62. **Clover and Its Relatives.**—Two of the most useful crops that can be grown on the farm are clover

and alfalfa. Clover and alfalfa are legumes. All legumes have irregular flowers, somewhat similar to those of the pea, and bear their seeds in pods or legumes. Below is a list of the common legumes:



Courtesy of the International Harvester Company

alfalfa
peas
beans

Canada peas
peanuts
vetch

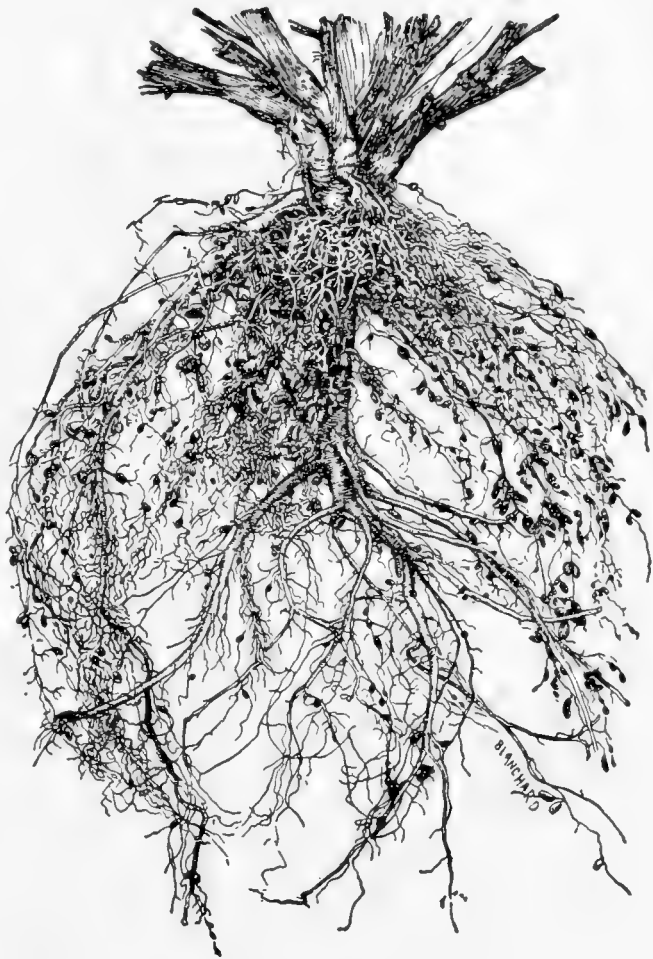
red clover
alsike clover
white clover
sweet clover
soy beans
velvet beans

Compare the flowers of a number of legumes and note their similarity.

63. **Legumes as Nitrogen Gatherers.**— We have already mentioned the fact that clover and other legumes have a special way of getting available nitrogen from the soil, which non-leguminous plants do not have. Since nitrogen is in the air, we might expect that all plants could get this nitrogen through their leaves, but no plants are able to do this.

All leguminous plants usually have on their roots, little swellings called *nodules* or *tubercles*.

These tubercles contain bacteria which have the power not only of taking the gas, nitrogen, from the soil, but also of making it into a nitrate, by uniting it with other elements. This nitrate serves as a raw food material for the plants on which the bacteria live.



RED CLOVER ROOTS
Showing Tubercles

Carefully dig up a clover, pea or bean plant, and gently shake the soil from the roots and notice the tubercles. It will not do to pull up the plants, as the tubercles will then be left in the ground.

Amounts of Nitrogen in Legumes.— One ton of red clover hay contains approximately 40 lbs. of nitrogen; one ton of alfalfa hay, 47 lbs., and one ton of soy bean hay, 48 lbs. It has been estimated that the roots and stubble of red clover and of alfalfa plants contain about one-third as much nitrogen as is found in the parts of the plant harvested. When the roots of legumes decay, the nitrogen they contain readily becomes available for the crops which follow. This is one of the reasons why planting of legumes has such a beneficial effect upon the crops which follow them in the fields.

Inoculation.— Sometimes the bacteria which make the tubercles on the roots of alfalfa, soy beans and all legumes, are not found in the soil where these crops are planted. Then, unless there is enough available nitrogen in the soil to supply the relatively large amount these plants require, they will not grow well. It is essential that these tubercle-making bacteria be added to the soil at the time of planting. These bacteria may be obtained from some field on which the particular legume, with roots showing a good supply of tubercles, has been growing successfully. If soil from this successful field is spread on the field about to be sown to the same leguminous crop, at the rate of 600 to 1000 lbs. per acre, enough bacteria will undoubtedly be supplied. When we add bacteria to a soil in the way just described, we call the process *inoculation*. Inoculation may also be accomplished by sprinkling the seeds with a liquid containing the desired kind of bacteria. Such a liquid is called a *culture*. Cultures

of bacteria may be obtained from the State Experiment Stations, and from the Department of Agriculture at Washington. They may also be purchased from manufacturers.

64. Other Uses of Legumes.—Leguminous plants benefit the soil in still other ways. Many of them, especially alfalfa and red clover, are deep feeders; that is, their roots go far down into the soil. Thus they feed on materials which many other plants cannot reach. When these deep-reaching roots decay, they leave the ground porous and thus permit, more readily, the entrance of water, air and other roots.

When a crop of clover or alfalfa is plowed under, not only are much nitrogen and organic matter added to the soil, but the amount of other raw materials, is considerably increased in the top soil. For instance, one ton of red clover hay contains about 40 lbs. of nitrogen, while one ton of timothy hay contains only 18 lbs. Alfalfa hay is even richer in nitrogen than is red clover hay, for one ton of alfalfa hay contains nearly 50 lbs. of nitrogen. Also since in one season two or more cuttings of alfalfa are generally obtained from one field, the crop yield of alfalfa is considerably greater than that of the other hay plants. For these two reasons, its richness in nitrogen and its greater crop yield, alfalfa is becoming a very popular crop in all parts of the country. Manure from animals fed on legumes is very rich in nitrogen.

The seeds of certain legumes are especially nutritious for man and for beasts. Beans and peas, and peanuts, for example, have always been used for food. They

are all rich in nitrogen and may to a large extent take the place of meat.

65. Legumes Need Lime.— Nearly all leguminous plants require a sweet and well drained soil. On sour soils, especially if the amount of available nitrogen is not very large, it is practically impossible to grow most legumes. One of the principal reasons for this is that the bacteria which make the tubercles and which supply the plants with available nitrogen, do not grow well in a sour soil and often do not grow at all. Often red clover refuses to grow on old fields where formerly it has grown luxuriantly, merely because the soil has become too sour. Alfalfa is even more dependent upon a sweet soil than is clover; and it always pays, before attempting to grow alfalfa, to see that the supply of lime in the soil is ample. Neglecting liming and inoculation in growing alfalfa are the principal causes of failure with this most valuable crop. One to two tons of finely ground limestone, or one-half to one ton of slaked lime per acre are generally used to sweeten sour soils and to fit them for either clover or alfalfa.

66. Fixation of Nitrogen and Nitrification.— The process of getting nitrogen from the soil air and changing it into a nitrate, so as to make it available for the use of plants, as we have described in talking of leguminous plants, is called *fixation of nitrogen*. To a very small extent atmospheric nitrogen is also “fixed,” that is, put into the soil in the form of a nitrate, by other bacteria than those which live on the roots of plants. We call these free living bacteria.

The term *nitrification* is often confused with the term *fixation of nitrogen*. Nitrification means making nitrates from the nitrogen combined with other elements in organic matter. When organic matter decays in the soil, certain bacteria act upon the nitrogen contained in this organic matter, and ultimately change it into a nitrate, in which form it is available for raw plant food.

67. Rotations of Crops.—The term “crop rotation” means the growing on a certain field of a series of crops in the same order for a given number of years. If on a certain field a farmer grows corn one year, barley the second year, clover the third year, and thus continues to grow these crops in this order year after year, he rotates these crops. Rotation of crops increases crop yields, controls weeds, insects and other plant enemies, equalizes the removal of raw plant food, and helps to maintain a good physical condition of the soil.

Rotation of Crops Increases the Yield.—All experimentation work shows that the crop yields are better when crops are rotated than when the same, or somewhat similar, crops are grown on the same fields year after year.

There are two reasons for the increased crop yields, due to crop rotation: pests, weeds, and diseases are held in check, and there is a balance of the removal of plant food because different crops use different amounts.

What is a Good Rotation?—A good rotation of crops should contain:

1. Shallow and deep rooted crops; 2. humus forming crops, as hay plants, and humus consuming crops, as the

grains; 3. cultivated and noncultivated crops; 4. legumes and non-legumes. When these four factors are found in rotation it is a good rotation.

Examples of rotation.—We commonly speak of a three, four, or five year rotation. Below are given a few examples of rotations.

Three Year Rotations

Corn, wheat, clover
corn, oats, clover
cotton, soy beans, clover
potatoes, rye, clover

Four Year Rotations

corn, wheat, clover, timothy
corn, peas, barley, clover
corn, corn, wheat, clover
corn, oats, hay, pasture

Make outlines of other rotations as diagramed above.

68. Nurse Crops.—Commonly clover, or clover and timothy seed are sown with some small grain seed, such as wheat, barley, rye or oats. These grain crops are then called *nurse crops*, and we say that clover was seeded with the grain. This saves a year and in favorable seasons both the nurse crop and the seeded crop give good results. When using the small grains for nurse crops the amount sown is generally less than when no grass crop, such as clover, or clover and timothy, is sown with it.

69. Plan of a Farm Showing the Rotations.—If a farmer has five fields of about equal size, his farm will be adapted either to a four year rotation with alfalfa on the fifth field, or to a regular five year rotation. The plan below shows a four year rotation with alfalfa. The four year rotation is corn, corn, oats and clover, rotated on four fields, and the alfalfa is on a separate field.

Field A 20 acres corn	Field C 20 acres oats	Field D 20 acres clover
Field B 20 acres corn		Field F 20 acres alfalfa

PLAN OF A FARM SHOWING THE ROTATION

In certain states corn is grown in rotation for two consecutive years. In others the small grains are. The rotations which are employed in various regions and under various circumstances are almost without number.

Make a plan of some farm and indicate the crops grown on each field for a series of years. Tabulate the rotation.

QUESTIONS AND PROBLEMS

1. Give all the reasons you can why legumes are useful to the farmer.
2. Have you ever observed that crops following legumes are better than similar crops following non-leguminous plants?
3. After you have gathered all the beans from a bean plant in your garden, carefully dig up some of the plants and look for nodules. Describe them.
4. Under what conditions would you plow under the whole clover crop and under what conditions stubble?
5. Why is it bad practice to raise tobacco on the same piece of land year after year?

6. What system of rotation do farmers in your community use? Make an outline of them. Why are these good or bad rotations?

7. What principles should guide in the sequence of crops in a rotation?

8. Make a plan of some farm and indicate the rotation followed on each field.

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Nitrogen Gathering Plants, Yearbook, Sep., 530, 5 cents.

Inoculation of Seed, B. P. I. Cir. 71, 5 cents.

Nitrogen — Fixing Bacteria, B. P. I. Bulletin 72, 5 cents.

Methods of Legume Inoculation, B. P. I. Cir. 63, 5 cents.

Planning Cropping Systems, B. P. I. Bul. 102, 5 cents.

Cropping Systems for Stock Farms, 1907 Yearbook, Sep., 5 cents.

Methods of Cultivation and Crop Rotations, B. P. I. Bul. 187, 15 cents.

Rotation Systems and Insects, 1911 Yearbook, Sep., 5 cents.

Rotations in the Corn Belt, Yearbook, Sep., 572, 5 cents.

Farmers' Bulletins.

Replanning a Farm for Profit, F. B. 370.

Legumes for Green Manuring, F. B. 278.

CHAPTER IX

CORN

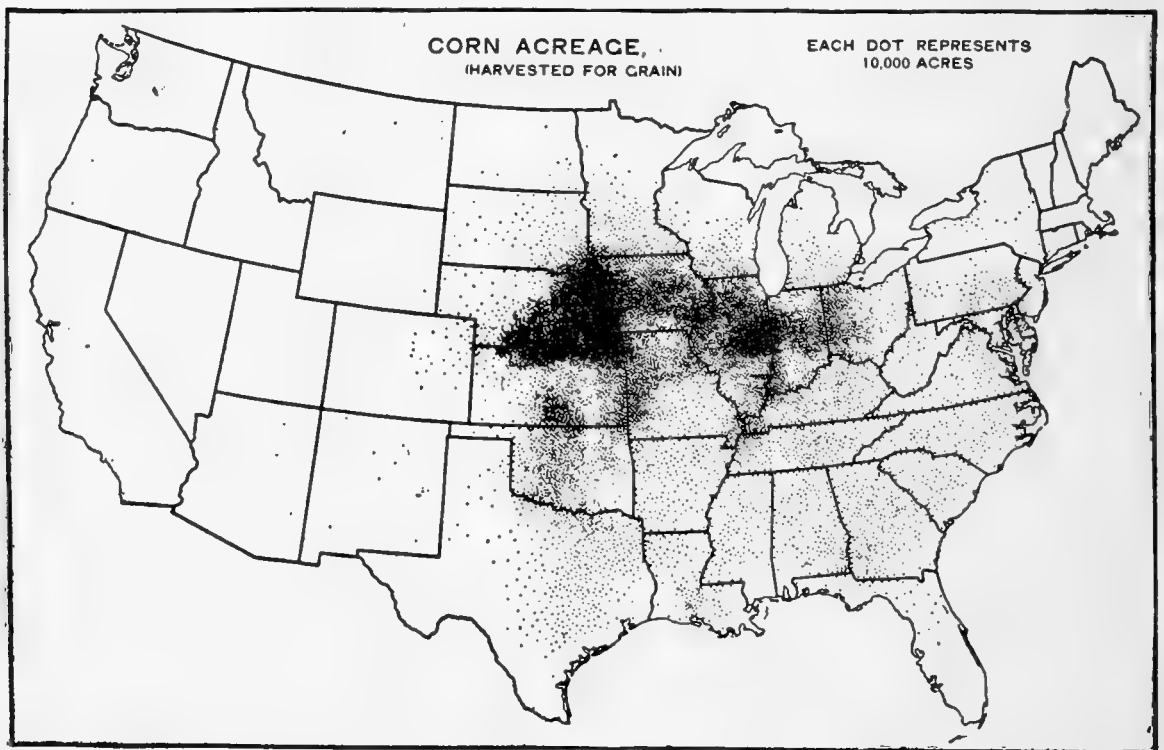
Corn is the most important grain crop grown in the United States. We raise about 70% of all the corn grown in the world and our annual production has been for many years between two and three billion bushels, while the average yield per acre has been approximately 26 bushels.

70. History and Uses.—Corn originated in America. It was the principal source of vegetable food of the Indians, and all the early explorers of America found the Indians growing corn. The Indians grew corn in practically the same way as it is grown to-day. To-day our leading cereal crop is corn. It is rightly termed, “The King of Crops.” It is the principal grain food for all our farm animals, and as corn meal, hominy, canned corn, and sweet corn, it forms an important source of man’s food. Corn is also extensively used in the manufacture of glucose, cornstarch, and liquors. When thus used, important by-products are obtained, such as feeds for cattle and other farm animals.

71. The Corn Belt States.—Ohio, Indiana, Illinois, Iowa, Missouri, Kansas, and Nebraska are commonly called the “corn belt” states, as these seven

states raise about as much corn as all the other states combined. These states have a soil and climate well adapted to the raising of corn.¹

72. Classes or Types of Corn.—There are four common types of corn; these are dent corn, flint corn, sweet corn, and pop corn. Each of these classes is in turn made up of many varieties or breeds. There are



Yearbook of the Department of Agriculture

about three hundred known varieties of dent corn. Each state has its own varieties especially adapted to growing within that state. Names of varieties best adapted to a state are issued by the state agricultural colleges.

Dent Corn.—Dent corn is the commonest corn grown. It is named from the fact that when a kernel

¹ The U. S. Agricultural Yearbook gives the amount of corn grown in each state each year.

of this corn ripens, a dent, or crease, is formed on the crown of the kernel. The ears of dent corn have a cylindrical shape, tapering slightly at the tip. They vary in length and in circumference. An ear eight inches long with a circumference of 6 to 7 inches, is an average ear and usually weighs about nine ounces. Most of the dent corn grown is either yellow or white.

Make a study of different varieties of dent corn noting the length, the circumference, number of rows, and of kernels per row.

Flint Corn.— The kernels of flint corn have no dent but are smooth and hard. They differ in shape from those of dent corn in that they are more rounded. The ears are generally longer and narrower. Ears of flint corn have fewer rows than ears of dent corn; eight rows are most commonly found. Flint corn matures earlier than does dent corn, and therefore, is grown more commonly in the northern states, especially in New England.

If flint corn is grown in your locality make a study of a few of the common varieties in the way outlined for dent corn.

Sweet Corn.— The type or class of corn known as sweet corn is grown entirely for human consumption. It differs from flint and from dent corn in that a large part of the starch turns to sugar. This gives to it a sweeter taste and a more translucent appearance than the other varieties of corn. The kernels of sweet corn are shaped somewhat similarly to those of dent corn but when mature, they are very much wrinkled. The

ears are generally smaller and narrower than those of dent corn.

Pop Corn.—Ears of pop corn, and the kernels also, are always much smaller than those found on any of the other three types of corn. Pop corn kernels are extremely hard. Because of this extreme hardness, which means that the materials composing it are very closely packed together, this corn pops or explodes when sufficiently heated. When it pops the starchy substance changes into a white fluffy mass which encloses the germ and the hull. There are two common kinds of pop corn, rice and pearl. The rice pop corn has sharp pointed kernels, while the kernels of pearl pop corn are round and smooth.

73. The Corn Plant.—The corn plant varies greatly in size according to the variety of corn and according to the climate in which it is grown. Some varieties of sweet corn never grow more than three feet tall and in the south many varieties of dent corn grow twelve to sixteen feet tall. The number of leaves on the corn plant varies according to the height and variety of the plant. The root system of the corn plant is very large, and after corn plants are about half-grown the roots of field corn occupy all the space between the rows.

Flowers.—The corn plant has two kinds of flowers. One kind occurs in the tassels and forms only pollen. The other kind is found on the young ears. The flower on the young ears has no stamen, but it has an ovary. The extension of the ovary, called the silk, extends beyond the husk of the young ear, to receive the pollen.

Corn is cross pollinated (page 9) and the wind carries the pollen from one plant to another. When different varieties of corn are planted too closely together, pollen from these different plants causes considerable crossing and this accounts for white kernels on yellow corn, and for sweet corn kernels on dent corn, and the like.

74. Seed Corn.— All good varieties of corn have been developed by careful selection until their characteristics are uniformly transmitted. Unless a special effort is made each year to select for seed only the best and truest ears, the quality of the corn will deteriorate. The corn selected should always be a good example of the variety to be grown. A corn score card shows the important points of an ear of corn, and is used in judging corn.

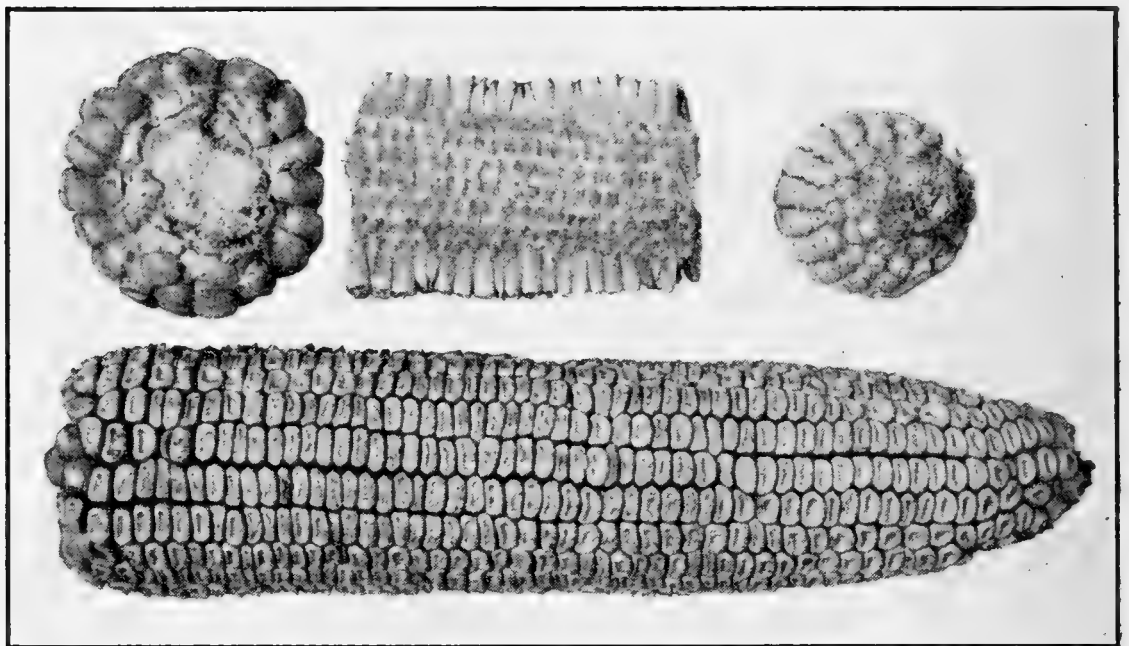


VARIOUS SHAPES OF KERNELS.— *Courtesy of the University of Wisconsin*

To judge kernels remove two kernels from each ear two-thirds of the way from butt to tip. Place each pair near the ear from which they were taken and compare

with the ideal. The top row here shown illustrates the best while those in the bottom row are too short and thick for dent corn. The long wedge shaped kernels shown at the right of the top row and the two pairs in the center of the row are desirable.

75. Selection of Seed Corn.—Seed corn should be selected in the field directly from the growing stalk. This should be done before the general harvesting and

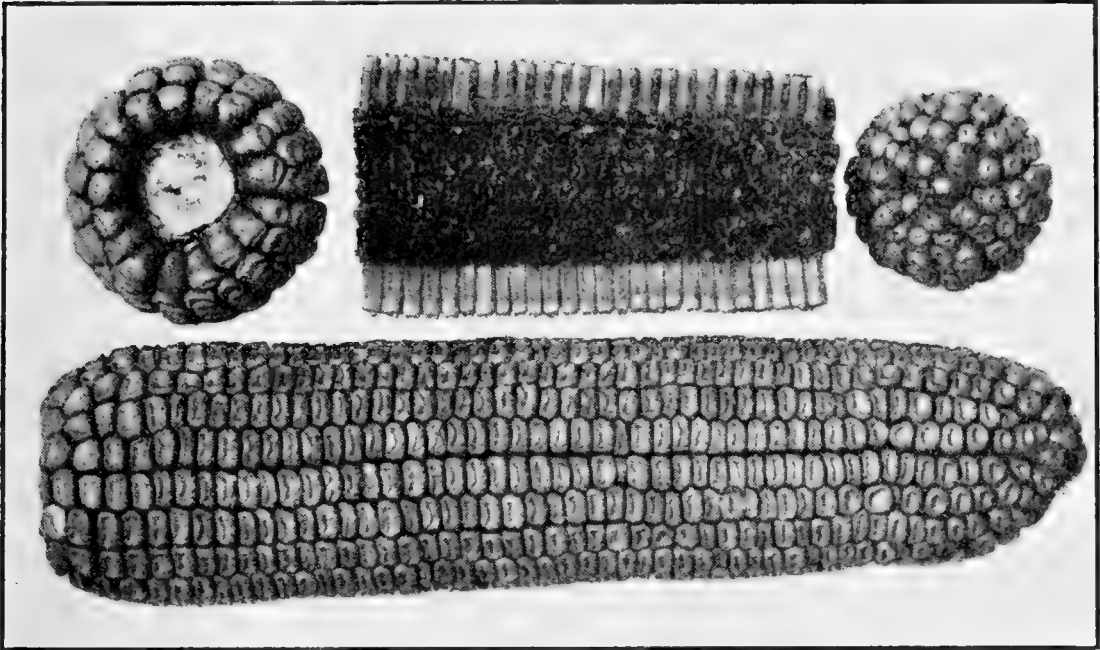


TWO UNDESIRABLE EARS

before a frost. When the husks and lower leaves have turned yellow and the kernels of corn are glazed, the corn is mature enough to be gathered. The ears should be typical of the variety in size, shape, color, and indentation. The ears should be well filled out, the kernels uniform. The plant from which the ears are selected should be strong and leafy; it should have matured a little earlier than the main crop; and it

should bear the ear at a height convenient for husking, that is, three or four feet from the ground.

At the time of maturity seed corn contains from 20 to 35 per cent. of water, and it is essential that such corn be removed on the day it is gathered to a suitable place where it can quickly dry out or cure.



TWO EARS OF CORN, SHOWING DESIRABLE QUALITIES FOR SELECTION

76. Curing Seed Corn.—The selected seed corn should be hung to dry at once on corn hangers, corn trees or stringers. It is essential that no ear touches another so that there will be a free circulation of air around each ear of corn. The room where the corn is hung should have a free circulation of air, should have protection against freezing temperatures, and should be dry. Artificial heat, although not essential, aids in the rapid curing of corn. When the corn is properly dry it can be hung in any dry room and freezing temperature will not affect it.

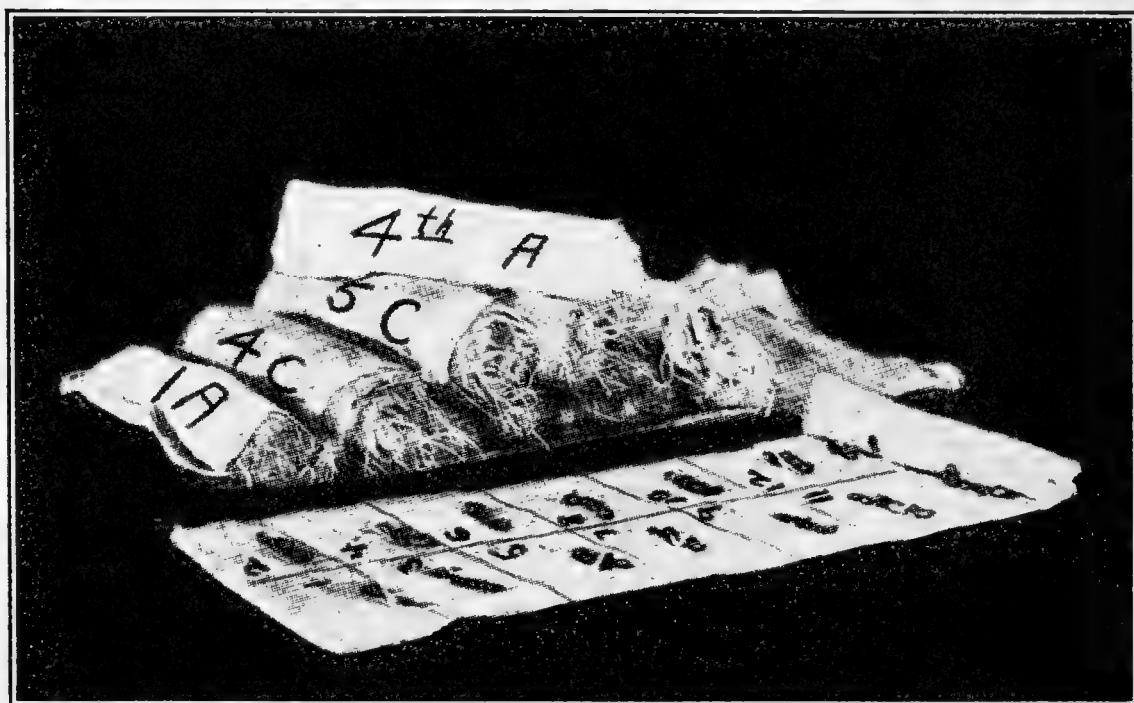
77. Testing Seed Corn.— February and March are good months in which to test the selected seed corn to find out its germination power. There are two common methods of testing corn, the sawdust germination box, and the rag doll. Either method will show the comparative germination power of the corn. Corn which is dead or weak when tested in the sawdust box will show up in practically the same way when tested with a rag doll tester and in the same way when planted in the field. Either method of testing enables one to pick out the strongest germinating ears, even though the conditions of germination are different from what they are when the corn is planted in the field.

Sawdust Box Method.— The standard box in which to test 100 ears at one time, is 30 inches square and four inches deep. In the bottom of the box is placed a layer of clean sawdust which has been thoroughly soaked in hot water. This is packed firmly and covered with a piece of wet, closely woven muslin, which has been marked off into 100 two and one-half inch squares, leaving a $2\frac{1}{2}$ inch border around the outside. The corners are tacked so as to hold the cloth in place. The squares are numbered one to one hundred, and the ears are also numbered and so arranged that the kernels from ear one are put into square one and so on. Six kernels, two from near the top, two from the middle, and two from the butt of the ear are removed and placed in the squares, with the germ sides up and the tips all pointing in one direction. The kernels are then covered with another piece of wet muslin which is also fastened at the four corners. Over this is placed another piece of

muslin large enough to allow 20 inches of material to project out on all four sides. Into this cloth is poured another layer of moistened sawdust, and this is also packed. The four extending sides are then thrown over the sawdust and the box is covered with a loose cover and inclined slightly so that the tips of the corn point downward. The box is then left at ordinary temperature. After seven days the top cloth with the sawdust is removed, and also the cloth directly over the seeds, and the test is then read. A strong germinating kernel will have three or four secondary roots and a large primary root. In a weak kernel the growth of roots will be much less, and in a very weak or dead kernel there will be little or no growth. Only the ears from which all six kernels sprout well should be retained for seed.

The Rag Doll Tester.—A piece of well washed, tightly woven muslin, 10'' wide and 28'' long, is large enough to test ten ears of corn by the rag doll method. Often twenty ears are tested in one doll, in which case the cloth should be about 40'' long. With a soft wax crayon 2½'' squares are ruled off on muslin, leaving a 2½'' margin on each side and a 7'' or 8'' margin at each end. The squares are numbered, and the cloth is then moistened, and spread out on a clean surface. Six kernels are placed in each square, germ side up and tips all pointing in one direction sidewise. The ears are marked so as to correspond in numbers to the squares. The cloth is then loosely rolled up without displacing the kernels. The ends are fastened with a rubber band or with a string, and the dolls with tips of

corn pointing down are put into a bucket of warm water over night. The next morning the water is poured out of the bucket and the bands or strings are removed, and the dolls are replaced in the bucket again with the tips pointing downward. The bucket is then covered with a cloth and kept at ordinary room temperature. Every two days the dolls should be soaked in



THE RAG DOLL TESTER

May be made at home for ten cents. This tester is now exclusively used at the Experiment Station in preference to all others.—*Bulletin 138, Iowa State Experiment Station.*

water for five minutes, so as to keep them moist. After seven days they may be removed and unrolled, and the test read as it was in the sawdust box method. When the cloths are boiled they are ready to be used again. One set of cloths may be used any number of times and should last several years.

78. Planting Corn.—Corn is generally planted 1" to 2" deep. There are three common ways in which

corn is planted, in hills, in drills, and listed. When corn is planted in hills the method is commonly called "check rowing."

Planting Corn in Hills.—Corn in hills can be cultivated in two directions and, on land that is comparatively level, check rowing corn is the most common method of planting. Usually three or four kernels are planted in a hill. The most common distance between the hills is 3' 8"; but much corn is planted with a distance of 3' 6" between the rows and hills. The soil and the climate determine largely both the rate of planting and the distance between the rows. When corn is planted in hills 3' 6" each way there are 3556 hills to the acre; and if each hill produced two ten-ounce ears the yield would be approximately 60 bu. per acre.

Drilling Corn.—When the land is uneven, and where the land is free of weeds, corn is usually drilled. The common distance between the rows is 3' 6" to 4'. The common distance between the plants in the drill or row is 12 to 14 inches. If the rows are 3' 8" apart and the corn is planted 14 inches apart in the row, the rate of planting is equivalent to checking 3 kernels at 3' 8". Silage corn on rich land is generally planted in drills 3' 6" apart, and the plants 6 to 8 inches in the drill. This will produce a very much larger yield of silage corn.

Listing Corn.—In the southwestern states, where the rainfall is likely to be deficient, the corn is listed. A special planter is used which drops the seeds in the bottom of a furrow 6 to 12 inches deep. When such

corn is cultivated, the soil between the rows is worked into furrows. This process increases the depth of the roots and thus the corn is better able to stand the drought.

79. Cultivation.—Corn is cultivated to keep the soil in a condition favorable for the rapid and continuous growth of the plant. In order to do this the weeds, which would otherwise take much moisture and raw plant food which should go to the growing corn, must be kept down, and the soil must be kept loose so that it can absorb much of the rainfall. Finally, a dust mulch must be maintained, until the corn stops growing. All experimentation shows that shallow cultivation, two or three inches deep, gives the best results. Corn should be cultivated frequently enough to keep the soil in the best condition for the growth of the crop. In some localities three or four cultivations are sufficient; in others, five or six are required. When there are no weeds, and where a good dust mulch has been established, no further cultivation is required until these conditions have been changed. When corn has grown too tall to be cultivated with a double cultivator, and the soil needs cultivation, a one horse cultivator is often used to maintain the proper soil condition. Hilling up the corn at the last cultivation is a bad practice, as this method destroys many roots, exposes others, causes more rapid evaporation, and leaves the soil in a bad condition which makes subsequent operations more difficult.

80. Harvesting Corn.—In the corn belt states much corn is husked by hand from the stalks and the

cattle are then turned in to clean up the field. Much corn is also cut with a binder, corn harvester, and by hand. Properly cured corn stalks give considerable feed and may take the place of grass hay. For silage, the corn is always cut with a binder and the bundles of corn are then easily hauled to the silo filler where the entire plants — stalks, leaves, and ears — are cut up into small pieces called silage. In the southern states corn is still commonly topped, and stripped. The tops and leaves are tied into bundles and used for feed. Later the ears are husked from the remaining parts of the stalks.

81. Corn Pests and Diseases.— The corn plant is attacked by many insect pests, such as cut worms, root lice, wireworms, earworms, and white grubs. Rotation of crops and occasional fall plowing is the only practical way of reducing the losses caused by these pests. The only common disease of the corn plant is corn smut. Corn smut, when mature, is easily recognized by masses of black powdery spores occurring on almost any part of the plant above the ground. Generally, however, the ears and tassels are the parts where these masses of spores most often occur. Since these spores live in the soil over the winter, rotation of crops, and the burning of the spore masses are the only practical ways of reducing the disease.

82. The Silo and Silage.— A silo is an air tight structure used for the preservation of green coarse fodder in a succulent or juicy condition. The green fodder in the silo is called silage. To-day every progressive dairy and stock farmer has a silo. Silage

makes excellent feed for cattle and for sheep. Some of the most important advantages of a silo are:

Economy in the storage of feed.

Small loss of a crop in harvesting.

Reduces waste in feeding.

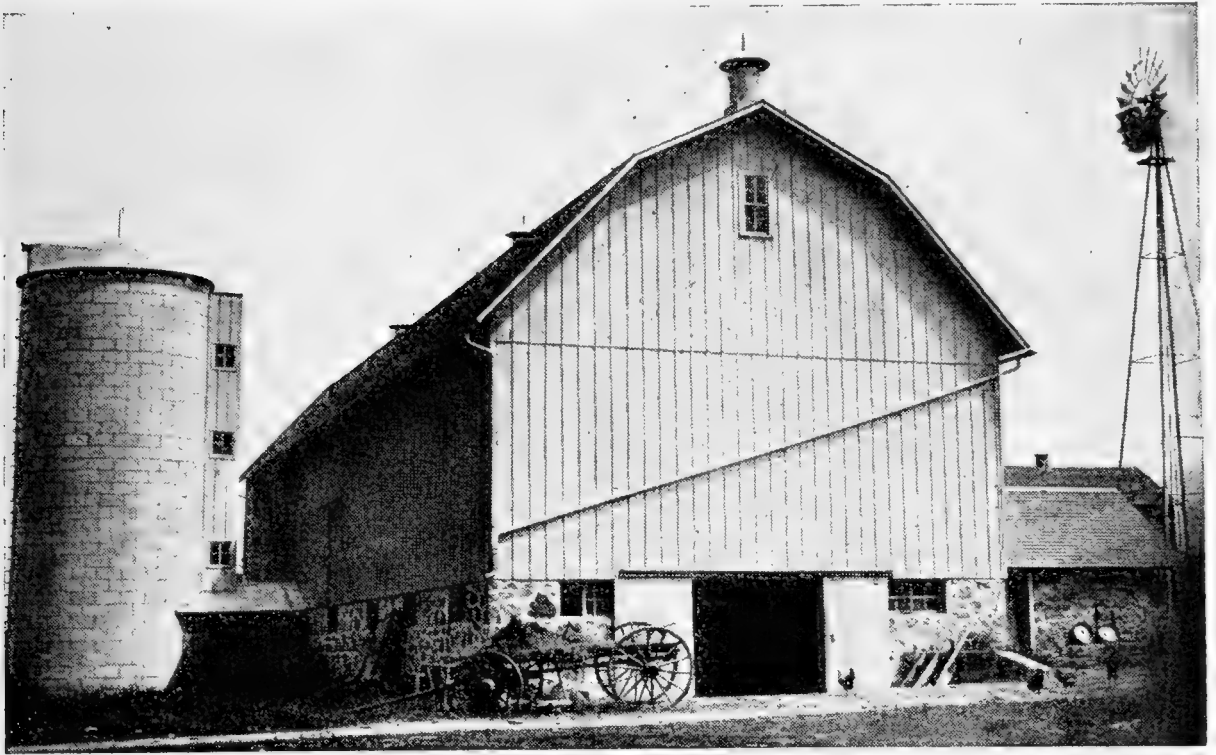
Corn silage is a much better feed than dry corn fodder.

Almost any green crop can be made into silage, but corn is the universal crop. It is estimated that the corn, which would make a 50 bu. crop per acre, will yield from 8 to 10 tons of corn silage. Thirty to forty pounds are commonly fed to cattle per day.

Form of Silos.—All recent silos are round and considerably greater in height than in diameter. Silos 12 x 28 or 14 x 32 are very common. The former holds about 60 tons of corn silage, the latter about 100 tons. The inner surface of the walls of all silos should be air tight, perpendicular and smooth, so that the silage can be firmly packed. Because of the great pressure of the silage the walls must be rigid and very strong. Brick, hollow tile, cement block, concrete, and wooden stave silos are very common in all parts of the country.

Principle of the Silo.—Bacteria and air readily cause all green succulent feed to spoil unless it is quickly dried. Bacteria pass into the silo with the corn, and for a short time they begin to grow, multiply rapidly, and act upon the corn producing fermentation. If there were an ample supply of air, these bacteria would finally cause the corn to decay, but since a silo is air-tight, the air within it when it is filled with silage

is very little and is soon used up and replaced by carbon dioxide. This lack of air checks the action of the bacteria, and the silage is then preserved much as is canned fruit in a tightly sealed can or glass jar. To be sure, the silo is open on the top, but because the corn is so well packed, practically no air moves down



EXCELLENT TYPE OF BARN AND SILO.—*Courtesy of International Harvester Company*

through the top layer. If this top layer is not quickly used it, of course, spoils. When a farmer starts to use the silage a layer of about one to two inches deep per day should be removed to keep the silage from spoiling.

83. Market Grades of Corn.—The surplus corn, which farmers do not need, is shelled and sold to grain dealers, who in turn generally ship it to the large markets. When a car load of corn reaches the large market, it is examined, sampled, and graded by grain

inspectors. The large grain dealers sell graded corn only. There are six well established grades of corn and the price of the corn varies according to the grade. This process of grading is a great advantage to both buyer and seller, as it establishes clearly the quality of the corn; and a purchaser generally gets the kind of corn he buys. The sales of corn, giving the amount and grade are published daily in newspapers.

QUESTIONS AND PROBLEMS

1. Is the state in which you live included in the corn belt?
2. How does the average yield of corn of your state compare with the average yield for the United States? Consult Yearbook of U. S. Department of Agriculture.
3. How many acres are devoted to corn in your county? What is the value of the corn raised? Consult Yearbook.
4. If by better selection of seed corn and by testing the seed corn the yield of corn could be increased 5%, what would be the value of the increase in your county?
5. What varieties of corn are raised in your community? Describe their characteristics.
6. Where and why would you plant corn in hills and in drills?
7. If corn sells for \$18.00 per ton in the fall and shrinks 10% in weight over winter, for how much must a ton be sold in the spring to make up for the loss in weight?
8. If corn were checked 3'6" \times 3'6" and the average hill produced two 12 oz. ears, calculate the yield of corn per acre.

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Commercial Grading of Corn, B. P. I. Bul. 41, 10 cents.

Directions for Coöperative Corn Breeders, B. P. I. Cir., 5 cents.

Shrinkage of Corn in Storage, B. P. I. Cir. 81, 5 cents.

* *Boy's Corn Clubs*, B. P. I. Circulars, 5 cents.

Lessons on Corn from Rural Schools, Dept. Bul. 653, 5 cents.

Farmers' Bulletins.

School Lessons on Corn, F. B. 617, F. B. 409.

How to Grow an Acre of Corn, F. B. 537.

Harvesting and Storing Corn, F. B. 313.

Seed Corn, F. B. 415, F. B. 229.

Corn Cultivation, F. B. 414.

Pop Corn, F. B. 553, F. B. 554.

Making and Feeding Corn Silage, F. B. 556, F. B. 578.

More Profitable Corn Planting Methods, F. B. 400.

Corn Ear Worm, F. B. 872.

Home Made Silos, F. B. 855.

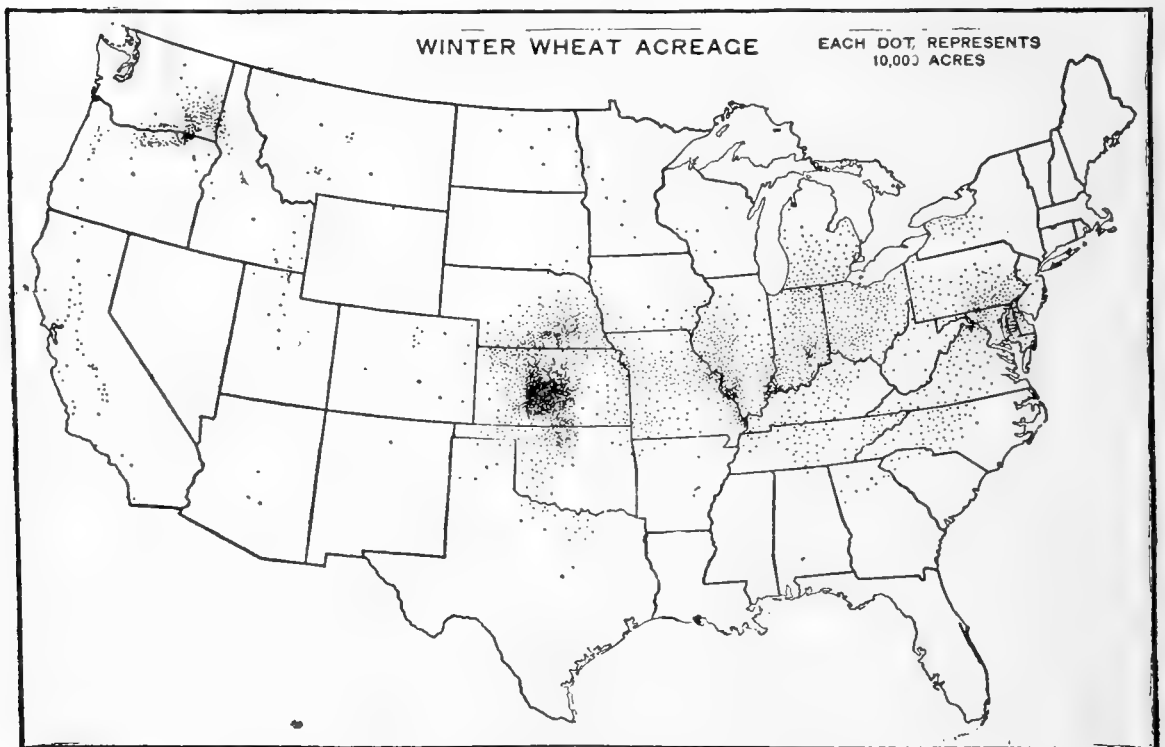
The Corn Earworm, F. B. 872.

The Rag-Doll Seed Tester, F. B. 948.

CHAPTER X

WHEAT, BARLEY, RYE, AND OATS

The four cereals, wheat, rye, barley, and oats have many things in common. All belong to the grass family of plants, and, like the majority of grasses, all have hollow stems except at the joints. The flowers, too,



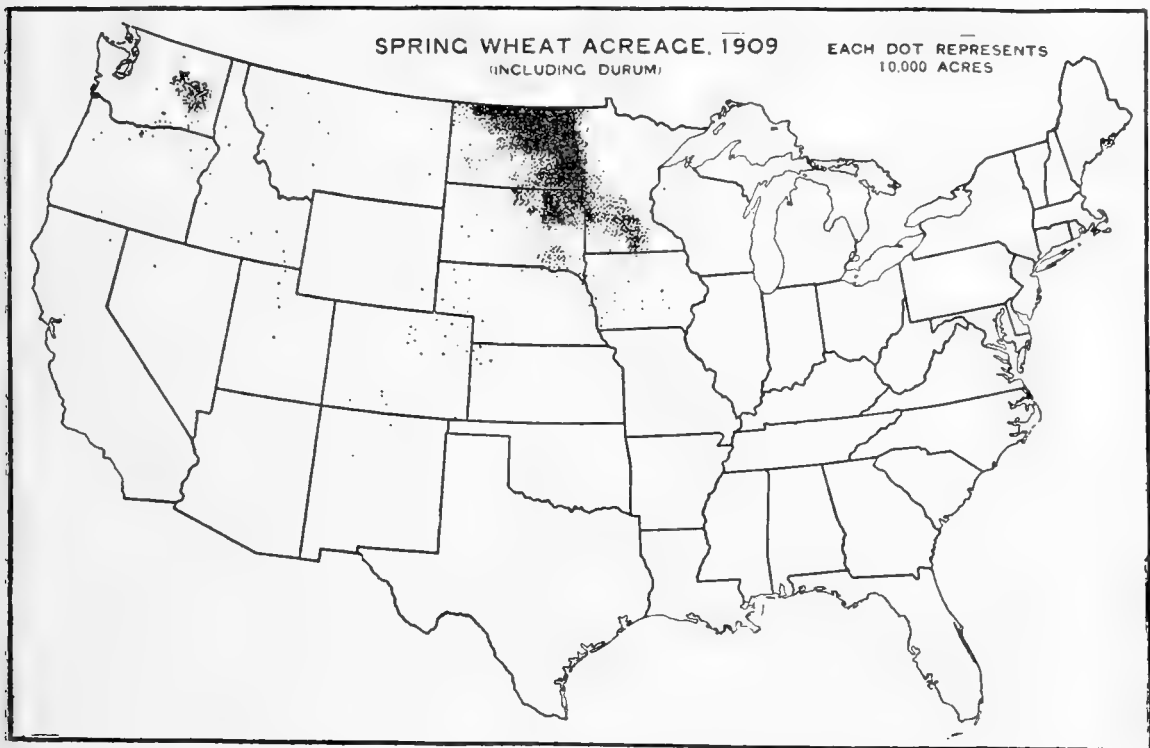
Yearbook of the Department of Agriculture

of all these four grains are very much alike, but they all differ very much from those of corn.

84. The Flowers and the Head.— Wheat has from three to five flowers placed in groups one above another

and slightly overlapping on two sides of the stem. Each of these groups usually bears three kernels of wheat.

Barley is of two kinds, the six-rowed and the two-rowed. The six-rowed barley has six rows of distinct flowers, three on each side of the stem. Each of these flowers produces a kernel of grain. In two-rowed



Yearbook of the Department of Agriculture

barley only one flower on each side of the stem develops into a kernel of grain.

Rye has four rows of flowers, two on each side of the stem, each of which produces a kernel.

All three of these grains, wheat, barley, and rye form their grains in a compact, elongated mass called a head. Oats differs from them. Oats forms its flowers, and consequently its grain, in clusters at the ends

of little stems. These clusters of flowers resemble the flowers of wheat, and each cluster generally forms two kernels of grain.

85. Varieties of Grains.—All our State Agricultural Colleges have been instrumental in developing varieties of wheat, barley, rye, and oats best adapted to their respective states. Any farmer may find out from his state agricultural college, or his county agricultural agent what varieties of these grains are best adapted to his soil and where the best seed can be obtained.

The teacher should get the pupils to bring in as many kinds of heads of grains as are grown in the neighborhood and the pupils should learn to identify the different kinds.

86. Our Wheat Crop.—Each year there are harvested in the United States about 700,000,000 bushels of wheat which is about 18% of the world's crop. For many years the average yield of wheat in the United States has been about 15 bushels per acre.

87. Use of Wheat.—Wheat is the principal cereal grain grown for man's food, and has been thus used for food since prehistoric times. The larger per cent of all the wheat grown is used for the production of flour and when so used it forms important by-products such as bran, shorts, and middlings. Flour is made from the starchy mass of the wheat kernel. The outer coats of the grain together with a little of the underlying layer forms the bran. When this bran is very finely broken, it forms shorts. Wheat middlings are much like shorts except that they contain more of the

white starch. These three by-products form excellent food for nearly all our animals. They contain more protein and ash than flour does but less carbohydrates.

88. Kinds of Wheat.—There are two common classes of wheat called the winter and spring wheat. Winter wheat is planted late in the summer and is extensively grown in Kansas, Nebraska, Oklahoma, Missouri, Indiana, Ohio and neighboring states. Spring wheat is grown farther north, and the Dakotas, Minnesota, and Montana lead in the production of spring wheat.

89. The Wheat Plant.—The roots of the wheat plant grow out sidewise until they meet those of adjacent plants; then they begin to grow down almost vertically. These roots are very numerous and form a fibrous mass. When the plant begins to grow, the nodes or joints on the stems are very close together and each node forms leaves, buds, and roots. At first only leaves appear above the ground, which always gives the young plants a leafy appearance. The buds develop into short stems which in turn branch, making the number of leaves and branches numerous. This process is called stooling or tillering.

Winter wheat passes the winter and early spring in this leafy condition and, finally as the season progresses, all the short stems begin to shoot up from the ground quickly. Spring wheat stools and then suddenly shoots up just as winter wheat does.

90. Growing the Crop.—Wheat prefers a cooler climate than corn, and a heavier soil. The best yields are obtained during cool and moderately moist springs

which are followed by warm, sunny weather during the ripening period. All experimental records show that drilling the seed into the soil gives better yields than does broad casting the seed. The reasons for this are that the seeds are more uniformly distributed, better covered, and planted at a more uniform depth.

The seed used should be carefully graded and only the largest and heaviest grade selected. When this grading or selecting of seed is not done, both the quality and the yield are decreased. This process of grading is generally done with a fanning mill, which not only removes the small, light, and shriveled grains, but also many weed seeds and broken kernels. Wheat makes a good nurse crop and it therefore generally precedes the grass crop in the rotation.

91. Harvesting the Crop.—Wheat is generally harvested with a self-binder when the kernels are beginning to harden and when the straw has begun to turn yellow. The self-binder drops the cut wheat in bundles called sheaves. These are then piled into shocks, made by placing ten or twelve bundles in a double row, the heads up, and the bundles leaning against each other. Generally two bundles are placed on top of each shock to act as a cap or covering. In the shock the ripening continues and the curing of the grain is accomplished. When the crop is dry enough, it should be made into stacks before it is threshed. If allowed to remain in the shock all this time, the quality deteriorates. Sweating in the stack prevents sweating after the wheat is threshed and actually improves its quality. In the West on the large

wheat ranches, the wheat crop is often allowed to ripen and cure before it is harvested. The crop is then gathered with a header, or combined harvester and thresher. The latter cuts and threshes the grain in one operation.

92. Wheat Diseases and Pests.—The common wheat diseases are rust, and smut; and the most abundant pests are the Hessian fly and the chinch bug.

Wheat Rusts.—Wheat rust appears as rusty and black streaks on the stems and leaves of the wheat plant. These streaks are masses of spores sent to the surface from the fungus which lives within the plant. The disease causes small, shrivelled, and light kernels of wheat, which greatly reduce the yield. The disease is most abundant in moist, warm weather. The only practical way of combating rust is by means of crop rotations and by the production of strong, vigorous plants.

Wheat Smut.—There are two different kinds of smut diseases affecting the wheat plant, the “stinking smut” and the loose smut.

Stinking Smut.—The fungus of the “stinking smut” lives within the tissues of the plant and forms a black mass within the grain. This black mass is a mass of smut spores. As the spores are most generally carried on the seed, this disease can be controlled by treating the seeds with formaldehyde before planting. The formaldehyde solution is made by adding one pint of commercial formaldehyde to 30 gallons of water. The seeds should be thoroughly moistened with this solution, made into a pile, and covered with sacks for two hours. After this the seeds should be spread out

and may be planted immediately or after they are dried out. There are now on the market dipping machines for treating seeds for smut.

The Loose Smut.— The fungus, known as loose smut appears when mature as a mass of black spores in the grain. The spores are generally carried by the wind and infect the head of the wheat when in the flowering condition. Since the disease is transmitted within the kernel it is difficult to control. A hot water treatment is sometimes used but this is difficult to handle correctly.

The Hessian Fly.— The Hessian fly is a small, black, two-winged fly much like a mosquito. It raises two broods in a year and the spring brood does a great deal of damage to the young wheat plants by eating the tissues of the plant. In the fall the flies emerge from the stubble of the previous wheat crop, and deposit their eggs on the upper leaves of the young, fall grown, wheat crop. The young which hatch from these eggs feed upon the wheat plant and work their way down between the leaf sheaves, to the base of the plant. Here they spend the winter in a resting condition. In the spring they emerge as adult flies and in their turn deposit eggs on the young wheat plants. The young from these eggs feed upon the young plants, and thereby not only greatly reduce the vitality of the plants but often kill many of them. Then the young or larvæ spend the summer in the stubble. Prompt plowing of the stubble helps to control these pests. If a strip of wheat is planted three or four weeks before the main crop, the adult flies generally deposit their eggs on

these first plants, and if this first planting is plowed under, late in the fall, the main crop may be protected.

93. Barley.—It has been estimated that fully one-half of the annual barley crop was formerly used for brewing and malting. Barley is also used extensively for the feeding of cattle, hogs and sheep, and when so used it is generally ground. A small amount of barley is used in the preparation of breakfast foods, and some is also used as pearly barley which is mostly utilized in soup, and a little is made into flour. Wisconsin, Minnesota, the Dakotas, Montana and California are our leading barley producing states.

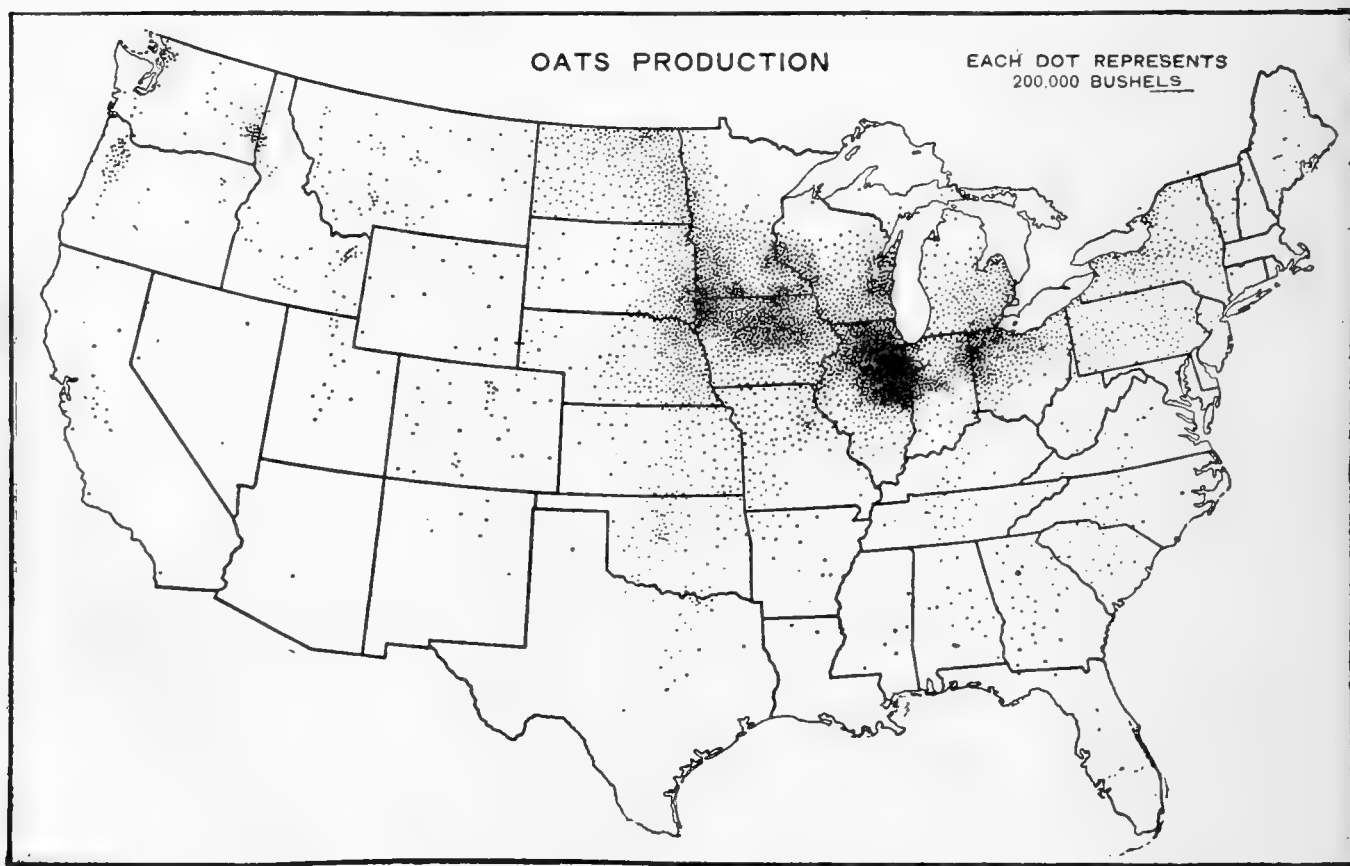
94. The Plant and Cultural Methods.—Barley, when growing, is very similar in appearance to wheat and rye but is generally not so tall. The leaves are a trifle wider than those of wheat and rye. Its habits of growth and cultural methods resemble those of wheat but barley requires a richer and slightly lighter soil than does wheat.

95. Rye.—Considerable rye is grown for the manufacture of rye flour which is used in making rye bread. Rye is also used for feeding farm animals and in this connection it may take the place of wheat. Some rye is used in the manufacture of liquors. Rye straw has a considerable number of commercial uses and surpasses in value the straw of the other grains. There is but one type of rye, but there are spring and winter varieties, the latter being most commonly grown.

96. The Plant and Cultural Methods.—In a general way the habits of growth and the cultural methods of rye are similar to those of wheat, but rye often grows

a little taller. Our north central states lead in the production of rye.

Rye is much hardier than the other cereals, and profitable crops may be produced on soils too poor for the profitable growing of the other grains. It is also best adapted to light soils. Because of these facts, rye is sometimes called the "grain of poverty." It is com-



Yearbook of the Department of Agriculture

monly grown as a green manure crop. Rye is often sown between the corn rows, and also between the rows of all other crops, during the latter part of August or early September.

97. Oats.—Oatmeal or rolled oats when properly cooked is one of the cheapest and best of the cereal

grains for man's food. Oats, however, find their greatest use as a feed for horses. Ground or crushed oats make a splendid grain for all farm animals. Oats are easily distinguished from the other grains because their grain is borne not in a compact head, but is loosely spread out. Each year we harvest about 1,000,000,000 bushels of oats and the average yield is about 30 bushels per acre.

98. Types of Oats.

— There are two types of oats, one called spreading oats, and the other side oats. The side oats differ from the spreading, in that all the branches hang on one side of the main stem. There are both winter and spring varieties, as in wheat. The winter varieties are sown in the fall but are grown almost wholly in the South. The spring varieties are planted in the spring and are commonly grown in the North. Some varieties of oats are black, some white, others red, and still others gray.



Spreading Head

Side Oats

TYPES OF OATS

*Courtesy of Iowa State Department of
Public Instruction*

The six leading oat producing states are:—Iowa, Illinois, Minnesota, North Dakota, Nebraska, and Wisconsin. These six states produce about 50% of the oat crop of the United States.

99. The Plant and Cultural Methods.—Oats thrive best in a cool, moist climate on the heavier types of soil. Like wheat, oats are commonly used as a nurse crop in a rotation. Where the soil is very rich, oats are apt to grow too tall, and lodge. Its cultural methods resemble those of wheat.

100. Enemies of Oats.—Oats are affected by a smut disease, as wheat is. The treatment for oat smut is identical with that for the stinking smut of wheat, and when the oat smut is so treated, the loss of the grain is greatly reduced. It pays well to treat oats for smut.

101. Seed Improvement.—The grains in a cluster of oats, as in wheat, vary greatly in size. Therefore the seed should be carefully graded by passing it through a fanning mill, and only the largest and heaviest kernels should be used for seed.

102. Market Grades.—The market recognizes three common classes of oats; white, red, and mixed. When oats is shipped to the large markets it is graded according to its quality into four grades and sold accordingly. Grade No. 1 representing the best quality brings the highest price.¹

¹ See *Grades of Grains* issued by the Illinois State Grain Inspection Dept., Chicago, Illinois.

QUESTIONS AND PROBLEMS

1. Why is there a difference in price between a bushel of wheat, oats, barley and rye?

2. How does the price of a bushel of corn compare with the price of a bushel of the other cereals?

3. What is the weight of a bushel of each of the common cereals?

4. Mention the principal uses made of the common cereals.

5. What would be gained in 60 days by feeding a horse 5 lbs. of corn and 5 lbs. of oats per day over 10 lbs. of oats per day? Use market values.

6. What was the latest estimated production of oats in your county and what was its value? (See census report.)

7. If the yield of oats could have been increased 5% by treating the seed for smut, what would the value of the increase amount to in your county?

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Spring Wheat in Great Plains Area, Bul. 214, 10 cents.

Experiments with Wheat, Oats, and Barley in So. Dak., Bul.
39, 10 cents.

Handling Wheat from Field to Mill, B. P. I. Cir. 68, 5 cents.

Swedish Select Oats, B. P. I. Bul. 182, 10 cents.

Barley Culture in North, B. P. I. Cir. 5, 5 cents.

Farmers' Bulletins.

Winter Wheat in Eastern U. S., F. B. 596, F. B. 616.

Growing Hard Spring Wheat, F. B. 678, F. B. 680.

Barley, F. B. 443, F. B. 427, F. B. 518.

Oats, F. B. 420, F. B. 424, F. B. 395.

Winter Oats for the South, F. B. 436.

Rye, F. B. 756, *Insect Enemies of Wheat*, F. B. 132.

Smuts of Grains, F. B. 507.

Durum Wheat, F. B. 534.

*How to Detect Outbreaks of Insects and Save the Grain
Crops*, F. B. 835.

CHAPTER XI

FORAGE CROPS

103. Hay and Grass Crop.— If a value were given to the pasture crop, it would greatly exceed the value of the hay crop, and the value of these two crops together, would then exceed that of corn. These crops also have an indirect value to the farmer, for when hay and pasture lands are plowed, there is added a great deal of organic matter to the soil. For many years there has been harvested on our farms between 80 and 90 million tons of hay.

There are many different varieties of grasses grown for hay in the United States, but the principal ones are timothy, and red top.

104. Timothy.— In value, timothy exceeds all other grasses grown for hay in the United States. Because of its freedom from dust, it is especially well adapted to the needs of horses. Timothy is easily distinguished from the other grasses because of its cylindrical head, 3 to 6 inches long. It is a perennial, and propagates by means of small, pointed, and solid bulbs, which are just below the surface of the soil, as are the bulbs of dahlia plants.

Remove some timothy roots and note the cluster of bulbs.

Timothy is a moderately coarse grass, growing from two to four feet high. It produces few leaves, is easily

cured, and easily handled. Timothy and a mixture of timothy and clover, fit well into rotations because when plowed under, the plants readily decay and add much organic matter to the soil.

When a mixture of timothy and clover is sown with a nurse crop, no crop of hay is harvested the same year as is the nurse crop. The second year, the crop of hay removed consists mostly of clover. The third year timothy will predominate and continue to do so.



Yearbook of Department of Agriculture

105. Red Top.—Red top is our second best known grass grown for hay. It differs from timothy in many ways. It has a spreading flower cluster, and not a cylindrical head as timothy has; it grows only 1 to 2½ feet high; it has slightly purplish flower clusters; and it has underground stems which make it a sod forming plant much like June grass. Red top grows best on

deep rich soils. It thrives well on soils which are too wet and too acid for timothy. Like timothy it is a perennial.

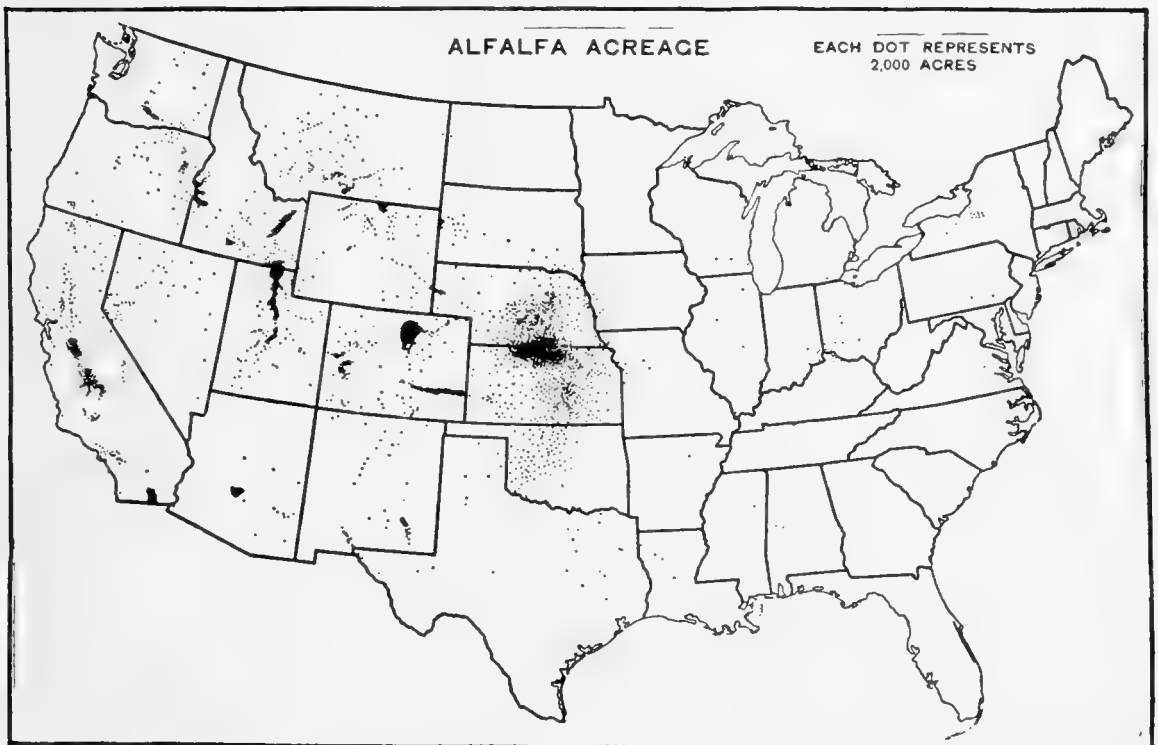
106. Legumes Grown for Hay.—The commonest legumes grown for forage purposes are medium and mammoth red clover, alsike clover, alfalfa, soy beans, and cow peas.

107. Medium Red Clover.—Medium red clover is often called common red clover and is grown more extensively for hay than any of the other legumes. Ordinarily it is a biennial; that is, it lives only two years. The plant is covered with fine hairs which tend to make the hay dusty, and therefore, not well suited for horses. The hay, because it is rich in protein, is excellent feed for all growing stock and for cattle. The plant has a long tap root which makes it a deep feeder. It grows best on sweet, well drained, loam or clay loam soils.

108. Mammoth Red Clover.—Mammoth red clover gets its name from the fact that it grows taller, and is coarser than medium red clover. The plant is also more hairy than that of medium red clover. Mammoth red clover is better adapted to poor soils than is medium red clover, but on poor soils the plant does not grow in as rank profusion, as it does on the richer soils. For soil improvement, and especially for sandy soils, mammoth red clover is better than any other clover plant.

109. Alsike Clover.—In some localities alsike clover is called Swedish clover. In general, its habits of growth resemble those of the red clovers. It differs from the red clovers, however, in that it is not as coarse

nor as tall, and has no silky hairs on its stems and leaves. Because the plant is not covered with these hairs, alsike clover hay is not dusty and may safely be fed to horses. The flowers of alsike clover are pinkish in color with considerable mixture of white. The lower part of the stems has a slight tendency to spread before the plant has grown erect.



Yearbook of Department of Agriculture

Alsike clover not only grows well wherever the red clovers thrive, but it also grows successfully on soils too wet for the red clovers. This is the principal reason why it is so extensively used.

110. Alfalfa.— Alfalfa is a long-lived perennial. It has a very long tap root which, on old plants, growing in suitable soils, often extends to a depth of 15 feet or more. From the top of the tap root, commonly called

the "crown," arise the shoots of the plant which are generally from two to four feet high. As the plant grows older, the number of shoots or branches greatly increases.

History of Alfalfa.—Alfalfa is a very old plant, grown by the Persians and Greeks more than two thousand years ago. It was introduced into the New England states early in the seventeenth century but attempts to establish it there were unsuccessful. The Spaniards, however, introduced it into Mexico and South America. In 1854, alfalfa was brought from Chile to San Francisco and from there it made its rapid spread throughout the West, and slowly worked its way eastward.

Importance of Alfalfa.—Alfalfa is gradually becoming one of our most valuable forage plants because it exceeds all other forage crops in yield per acre, in feeding value, as a drought resister, and as a soil enricher.

In most sections of the United States two to four cuttings are obtained every year; and when alfalfa is once planted it usually may be allowed to grow four or five years without reseeding. Alfalfa is one of the most nutritious feeds for all classes of farm animals. In many sections of the country all classes of livestock are maintained during the winter on nothing but alfalfa.

Growing the Crop.—To grow alfalfa successfully the soil must be deep, fertile, well drained, sweet, free from weeds, and contain the proper soil bacteria. The lack of some one of these essential requirements is the cause of failure in attempting to grow alfalfa. In Chapter VIII we have spoken of the benefits of liming and of inoculating soils, and, throughout the eastern and southern

parts of the United States it almost always pays well to both lime and inoculate before alfalfa is grown.

Harvesting the Crop.—Alfalfa should be cut when about one-tenth of the plants are in blossom, or when new shoots are beginning to appear on the crown of the plants. These new shoots grow more quickly after the older parts of the plant are removed. If the cutting of the older parts is delayed until these new shoots have grown tall enough to be cut with the mower, the ensuing crop will be greatly retarded. Hay caps not only protect the hay from rains but they also improve the feeding value of the hay.

111. Soy Beans.—The soy bean, often called soja-bean, is an upright, branching annual legume from 2 to 4 feet high. It is abundantly supplied with leaves and when mature the plant possesses many small pods somewhat similar to those of the garden bean. The leaves and the seeds are the most valuable part of the plant when grown as a forage crop. The nodules forming on the roots are often as large as a pea seed; it is supposed that in many soils the proper nodule-forming bacteria are wanting and that soils where soy beans are to be grown should therefore be supplied with the bacteria by some method of inoculation. Both the plant and the seed are rich in nitrogen and the seeds contain much fat.

112. Cowpeas.—The cowpea is also an annual legume. Though it is a native of the Southern states, it is now successfully grown in the North. The hay made from cowpeas is fed to all kinds of livestock and has the same general uses as soy bean hay. The seeds, when ground, make a very rich concentrate, and are fed to

animals as grain, replacing other similar rich feeds such as oil meal and cottonseed meal. Also a considerable amount of cowpeas is grown that their seeds may supply food for man. Because of the heavy growth which cowpeas make, they are extensively grown for green manuring.

QUESTIONS AND PROBLEMS

1. What crops are raised in your community for hay?
2. Describe how hay is harvested in your community.
3. Do the farmers in your community use hay caps? Hay loaders?
4. How many acres of alfalfa are there in your school district?
5. What must be done in your community to grow alfalfa successfully?
6. Are cow peas and soy beans grown in your locality?
7. How many pounds of digestible protein per acre can be obtained from an alfalfa field if the yield from three cuttings is 4 tons? (Use Table 4, Appendix.)
8. From a clover and timothy field if the yield is two tons per acre?
9. From a timothy field if the yield is two tons per acre?

Farmers' Bulletins.

Red Clover, F. B. 455, 451.

Alfalfa, F. B. 339.

Soy Beans, F. B. 372.

Vetches, F. B. 515.

Canada Field Peas, F. B. 224.

Sudan Grass, F. B. 605.

Commercial Varieties of Alfalfa, F. B. 757.

Canada Blue Grass, F. B. 402.

Field Peas as a Forage Crop, F. B. 690.

Cowpeas, F. B. 318.

Sweet Clover, F. B. 485.

Millets, F. B. 101.

Rape, F. B. 164.

Sorghums, F. B. 246, 458.

Market Hay, F. B. 508.

Haymaking, F. B. 943.

Sundry Publications.

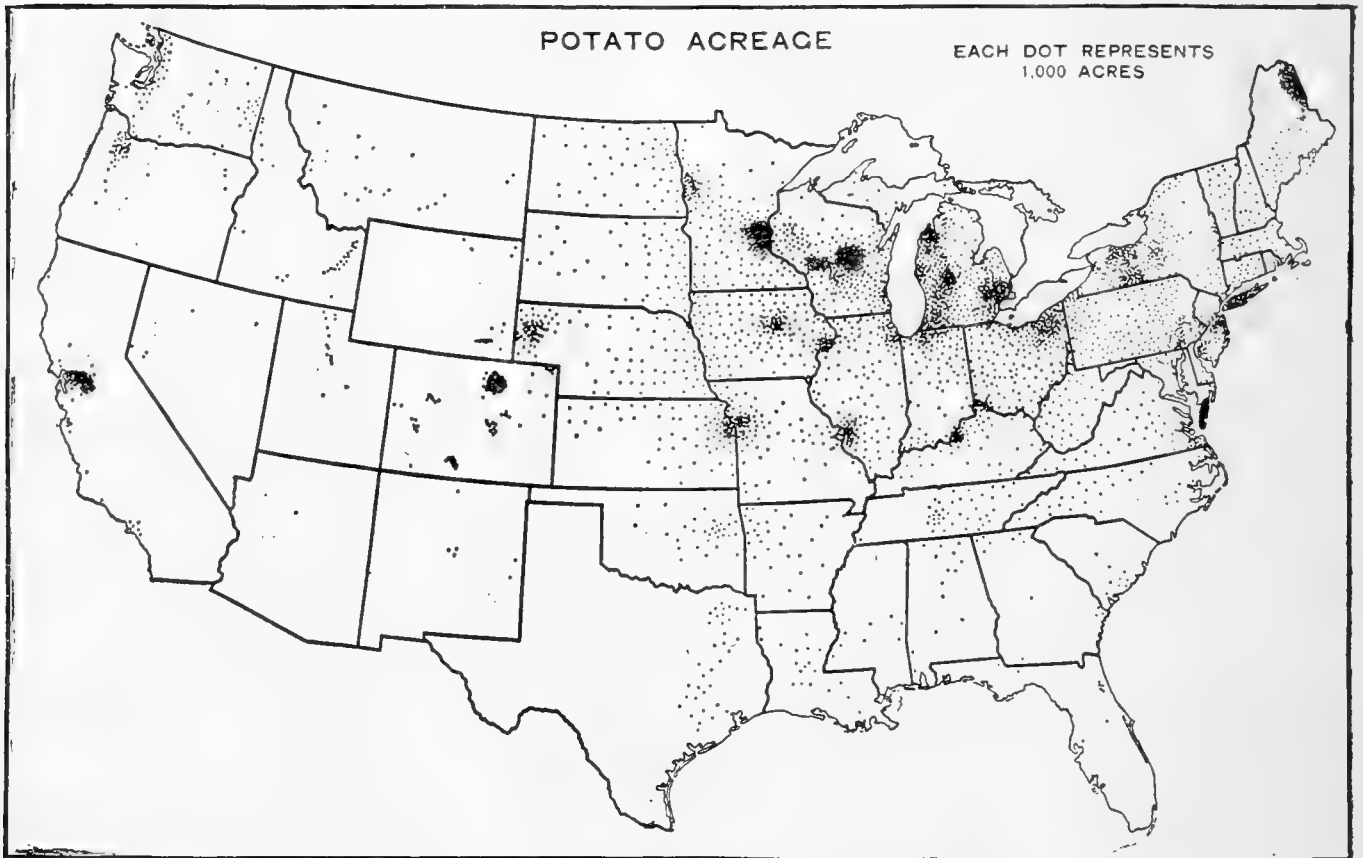
Hand Book on Forage Crops, by The Albert Dickinson Co.,
Free. Chicago, Illinois.

For Better Crops, by the International Harvester Co., 6 cents.
Extension Dep't., Harvester Bld'g., Chicago, Ill.

CHAPTER XII

OTHER FARM CROPS

113. **Potatoes.**— Our common potato is often called the Irish potato, and sometimes the white potato, to distinguish it from the sweet potato. The common potato



Yearbook of Department of Agriculture

is a native of South America where the early Spanish settlers found it growing. To-day potatoes are grown practically in every country.

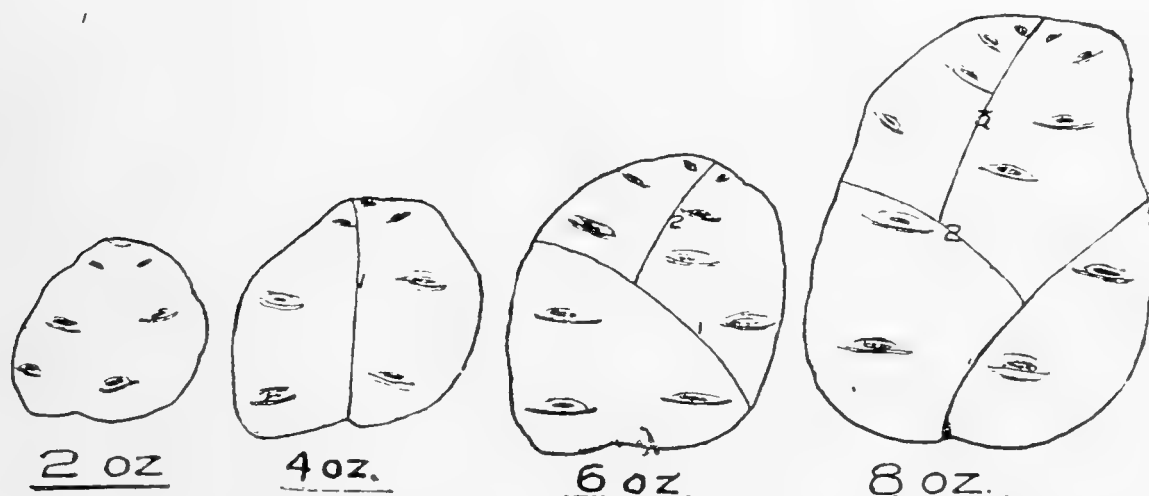
The states leading in the production of potatoes are:

- | | | |
|--------------|-------------|------------------|
| 1. Minnesota | 3. New York | 5. Michigan |
| 2. Wisconsin | 4. Maine | 6. Pennsylvania. |

114. Varieties of Potatoes.—The varieties of potatoes are very numerous. Some of the most common ones grown in the United States are:—

Early
Early Ohio
Early Rose
Irish Cobbler
Triumph

Late
Rural New Yorker
Carman
Burbank
Green Mountain



Cutting Potatoes for seed. Note the size of the pieces.

Courtesy of Iowa State Department of Public Instruction

115. Seed Potatoes.—As in the case of other crops, the potatoes used for seed are an important factor in determining the yield. Potatoes are raised from seed pieces or cuttings; that is from sections of a potato containing one or more eyes, preferably two. The eyes are really buds, for the potato tuber is merely an enlarged underground stem and not a root. The potatoes used for seed should be a good example of the variety; should

be pure; should come from productive plants; should be uniform in size and in shape; and should be sound and

firm. The seed should preferably be selected in the field when the potatoes are dug, and should come from hills containing six or more sound, medium-sized potatoes.

Although we have, for many years, harvested between 300 and 400 million bushels of potatoes, we produce only about 7 per cent. of the world's crop. Our average yield per acre is about 95 bushels. In England the yield per acre is about twice as great.



POTATO PLANT
Showing Potatoes or Tubers

116. Cultural Methods.—The best yields of potatoes are obtained on light, loam soils, well-drained, and rich in vegetable matter. Because of this need of vegetable matter in the soil, potatoes are often planted after a clover or grass crop. The seed pieces are planted deeply, three to five inches, because the new potatoes are developed at the ends of small branches growing out from the short nodes or joints of the underground stem. Potatoes are planted in rows 30 to 36 inches apart and the seed pieces are dropped 12 to 18 inches apart in the row, either by hand, or by means of a potato planter.

117. Potato Diseases and Pests.—The two most common diseases of the potato are scab, and blight, and the common pest is the “potato” bug or Colorado potato beetle.

Potato Scab.—Potato scab is a fungus disease affecting the skin of the potato, causing it to become rough with elevations and depressions. The spores causing the disease winter in the soil and on the infected potatoes. It is supposed that the principal source of infection comes from infected seed potatoes. Potato scab may be largely prevented by clean seed, by rotating crops, and by soaking the seed potatoes for two hours before planting in a solution of formaldehyde, made by adding one pint of formaldehyde to thirty gallons of water.

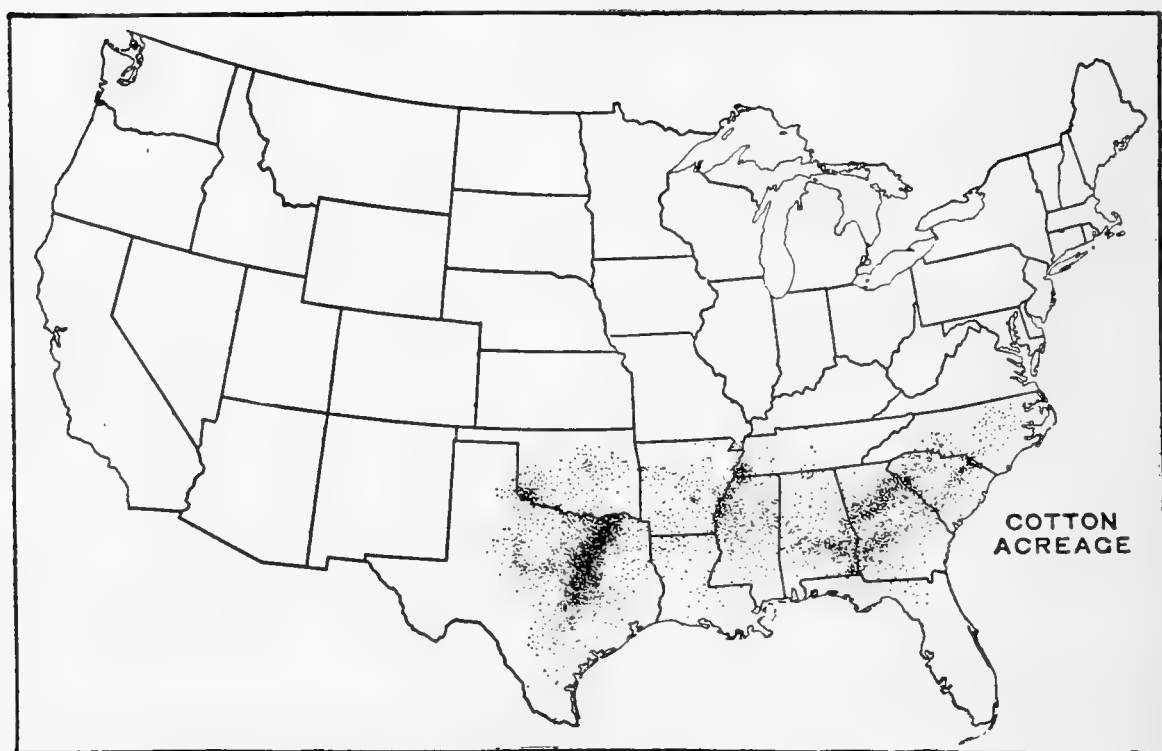
Potato Blight.—There are two potato blight diseases, one called the early blight and the other, the late blight. Both the early and the late blight make their first appearance as brown spots on the leaves of the potato plants. These spots enlarge until the entire leaf becomes brown and withered. While the leaves are thus being destroyed the stems gradually turn yellow; then they, too, become brown and die.

The remedies for both kinds of potato blight are 1, clean seed potatoes; 2, crop rotation; 3, spraying the growing plants with Bordeaux mixture.

The Colorado Potato Beetle.—The Colorado potato beetle is commonly called the potato bug. The adult beetle lays masses of small orange-colored eggs on the under surface of the potato plant leaves. In about a week these eggs hatch into small, soft, reddish larvæ which feed upon the leaves. These larvæ have ravenous

appetites and if unchecked, they will soon destroy all the foliage. They are usually killed by spraying the potato vines with a poisonous substance such as Paris green, or arsenate of lead. (See Chapter XX.)

118. Cotton.— The principal crop of the Southern states is cotton. Cotton is the most valuable fiber crop grown. In addition to the lint, it produces seeds from



Yearbook of the Department of Agriculture

which cottonseed oil and cottonseed meal are made. These by-products are very valuable. Cotton is grown in all warm countries; and, although it is a tropical plant, it thrives well in the warmer parts of the temperate zone.

Our principal cotton growing states are: —

Texas	Mississippi	Arkansas
Georgia	Oklahoma	Louisiana
Alabama	South Carolina	North Carolina

119. **The Plant and Cultural Methods.**—The cotton plant is quite large and much branched. It commonly grows from 4 to 6 feet high. It is an annual and the crop is grown much like corn. Usually the rows are four feet apart, and the plants 14 to 20 inches apart in the row. The crop is cultivated just as corn is. The plants produce large oval leaves, four to five inches wide, and numerous large flowers. Each of these flowers, when mature, develops into

a large, somewhat egg-shaped structure, called the boll. When ripe the boll bursts open, showing the white woolly lint, which is attached to the seeds. The lint together with the seed is picked out of the bolls by hand, and the seeds are then separated from the lint by a machine called the cotton gin. When a successful cotton picking machine comes



COTTON PLANT

a., flowering branch; *b.*, fruit (boll) bursting; *c.*, seed with fibers (lint).—*Wossidlo.*

into general use, it will solve a troublesome labor problem in the production of this staple. The United States produces about one half of the world's cotton crop and for many years our crop numbered from 10 to 15 million bales of lint, each bale weighing 500 pounds.

120. Tobacco.—In various parts of the United States the raising of tobacco is an important industry. The United States raises a little less than one-half of the world's tobacco crop. Our average production is about 1 billion pounds. The states leading in the production of tobacco are given below:

- | | | |
|-------------------|-------------|--------------|
| 1. Kentucky | 3. Virginia | 5. Tennessee |
| 2. North Carolina | 4. Ohio | 6. Wisconsin |

121. Cultural Methods.—Tobacco differs from the other crops we have been discussing in that the plants



TOBACCO PLANT

are started in a special seed bed, hot bed or cold frame and then transplanted to the field. The seed is sown early in a specially well prepared seed bed, which is usually in a sheltered place where the young plants may be protected. Often the entire seed bed is covered with cheese-cloth or

with glass. When the young plants are three or four inches high, they are transplanted to the field where they are planted in rows, 3 to 4 feet apart, with the plants 14 inches to two feet apart in the rows, the exact distance depending upon the variety of the plant. The crop is then cultivated just as other crops

are cultivated. Tobacco thrives best on a light, rich soil, and usually only the best and richest fields on the farms are planted to tobacco. The transplanting was formerly done entirely by hand, but now, where much tobacco is grown, transplanting machines are extensively used.

When the flower buds appear, the top of the stem is broken off about three feet from the ground so that all the nourishment goes to the leaves, thereby causing them to grow as large as possible. This process is called topping. The young shoots, called suckers, are also broken off.

122. Harvesting the Crop.—As the leaves ripen, there are two methods of harvesting the crop. In one instance, the leaves are broken from the plant and hung in a shed to cure. In the other method, the entire plant is cut down, when the lower leaves are just beginning to ripen, and hung in a shed. In the latter method, the leaves do not all cure alike, as they do when all are allowed to ripen on the plant before they are gathered, but as the method involves much less work, it is more commonly used.

123. Curing Tobacco.—The separate leaves, or the stalk and leaves, after they are gathered and hung in the sheds, are allowed to dry, and at the same time, to undergo a change called curing. The value of the leaf depends to a considerable extent on the satisfactory completion of this curing. The sheds are constructed so as to regulate the supply of air currents, moisture and heat.

124. Rice.—Rice is one of the most important foods

of the human race and especially of the people living in China, Japan, India and Egypt. These four countries lead in the production of rice. Although many of the southern states are adapted to growing rice, we import more than we raise; and more attention should be given to the culture of rice in the United States. In form and structure the rice plant bears some resemblance to the other cereal grains. The head of the plant is spreading and resembles that of oats. The grain has the outer coverings attached just as oats have, but the naked kernel looks much like that of wheat in shape, color and size. The kernels of rice we buy to eat have had the outer coats or bran removed and have been polished to give them their gloss, thereby losing much of their nutritive value as food. Rice is grown on rich low land which can easily be flooded or irrigated.

125. Sugar Cane.—The granulated sugar we eat is made either from sugar cane or from sugar beets. Cane sugar is made from the sugar cane plant, which grows only in tropical or sub-tropical regions. The sugar cane plant somewhat resembles the corn plant. It has stems, 8 to 20 feet high, which are from one to two inches thick. The plant is propagated by cuttings of the stems which bear buds at the nodes. Trenches are plowed and pieces of the stalks, each bearing at least one node, are dropped in the trenches and covered. The land is then tilled to keep it free of weeds. At harvest time the plants are stripped of their leaves and topped, and the stalks are then cut, close to the ground. New plants spring up from the stubble. The stalks are taken to factories where they are crushed and the sugar is made from the

juices they contain. Louisiana and Texas are the principal states producing cane sugar. Cuba, Porto Rico, Hawaii and the Philippine Islands are important cane sugar producing countries.

126. Sugar Beets.—The sugar beet is a large, whitish, and conical shaped beet. The plant resembles the common garden beet, and differs from it only in that its leaves are much larger and coarser. The sugar beet is an important plant, as about one-half of all the sugar used is beet sugar. Sugar beets thrive best in a cool, moist climate and are therefore best adapted to the northern states.

The crop is grown just as the garden beets are grown, but where extensively raised, the crop is planted with a special, four-row beet planter and also cultivated with a four-row cultivator. When the crop is ready to harvest, the beets are generally dug with a beet digger. The crowns of the plants are then cut off by hand and the leaves and crowns are fed either to stock or left on the ground to be plowed under. The beets are hauled or shipped to the beet sugar factories where they are thoroughly washed, sliced, and steamed to dissolve and remove the sugar. The syrup thus obtained is purified and granulated. The by-product, beet pulp, is either fed to stock or it is dried and sold on the market as dried beet pulp.

QUESTIONS AND PROBLEMS

1. What percentage of the total potato crop of the United States does your state grow? (Refer to your state census report if necessary.)

2. What are the most common varieties of potatoes grown in your community?

3. Why are potatoes such a popular and important article of diet?

4. What are some of the articles made from cotton?

5. Give the history of the cotton gin.

6. Look up the history of the introduction of tobacco into England.

7. Tell why a crop of tobacco is harder on the soil than is a crop of corn. (See Table 2 appendix.)

8. Is beet or cane or maple sugar used in your home? Which do you prefer?

9. If potatoes are planted in rows 3 feet apart and 12 inches apart in the row, how many hills are there per acre?

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Lessons from Potato Growers in Germany, Bul. 47, 5 cents.

Potato Growing Clubs in the North and West, B. P. I. Paper.
5 cents.

Varieties of Potatoes, Bul. 176, 20 cents.

Principles and Practical Methods of Curing Tobacco, B. P. I.,
Bul. 143, 10 cents.

U. S. Official Cotton Grades, B. P. I. Cir. 109, 5 cents.

Lessons on Cotton for Rural Schools, Bul. 294, 5 cents.

Insect Enemies of Tobacco, Yearbook Separate, 537, 5 cents.

Potatoes as Food, Bul. 468, 5 cents.

Farmers' Bulletins.

Potatoes as a Truck Crop, F. B. 407.

Good Seed Potatoes, F. B. 533.

Potato Diseases, F. B. 544, 91.

Tobacco Culture, F. B. 571.

Curing Tobacco, F. B. 523.

Cotton Improvement, F. B. 501, 601.

Sea Island Cotton, F. B. 302, 787.

Cotton Culture, F. B. 314.

The Sugar Beet, F. B. 52, 568.

Irrigation Practice in Growing Rice, F. B. 673.

Increasing the Potato Crop by Spraying, F. B. 863.

Tobacco Culture in Penn., F. B. 416.

Tobacco Culture in Tenn., F. B. 343.

Rice Culture, F. B. 417

Manures for Cotton, F. B. 48.

Sweet Potatoes, F. B. 324.

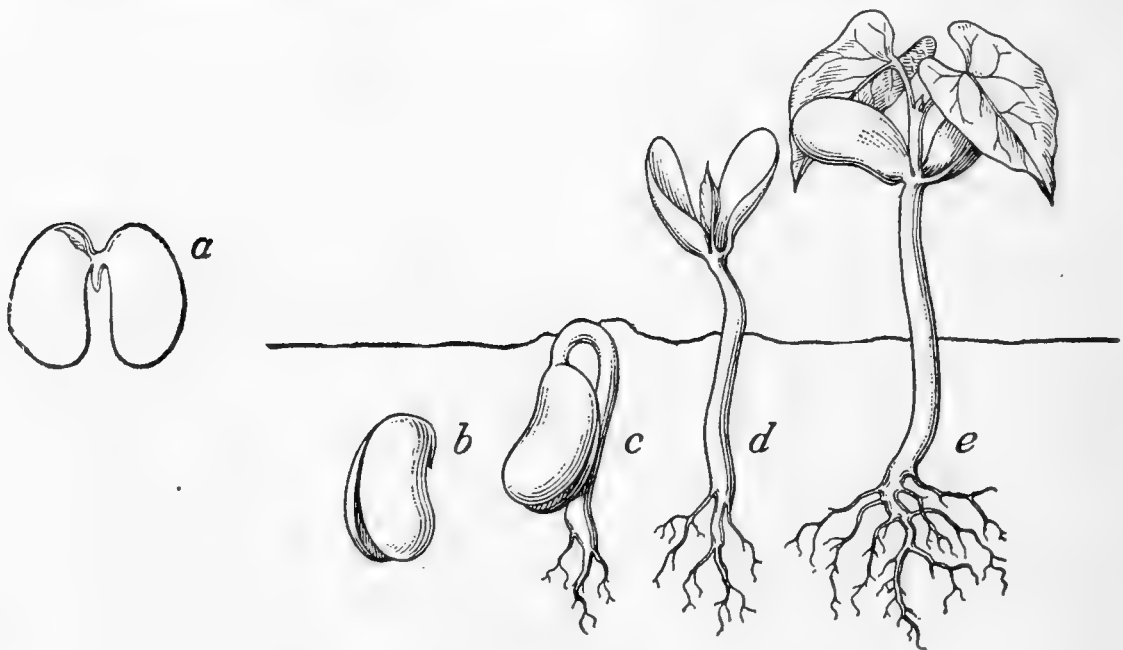
Sugar-Beet Sirup, F. B. 823.

CHAPTER XIII

SEEDS

All seeds are formed by flowers and their formation involves the processes of pollination and fertilization. Seeds contain both a little immature plant and some stored up food. Seeds form a large part of man's food.

127. Plant Food in Seeds.— All three of the classes



LIMA BEAN

a, cotyledons opened to show hypocotyl and plumule; *b* to *e*, successive stages in germination showing development of hypocotyl, roots, cotyledons, stem, and plumule.

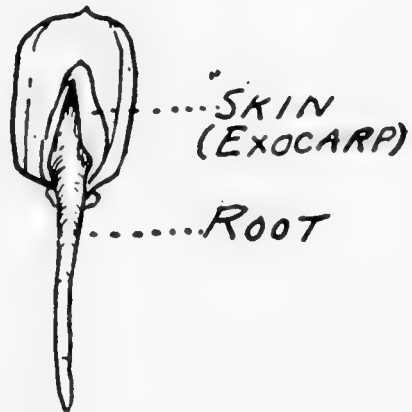
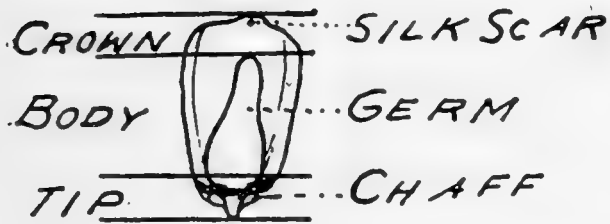
of food are found in seeds: these are the *carbohydrates*, the *proteins*, and the *fats*.

Carbohydrates.— Starch and sugar are examples of carbohydrates. In all seeds we find considerable starch,

but very little sugar. The starch is insoluble, so when the seed begins to germinate, the starch is changed to sugar and in this form it readily moves to the growing

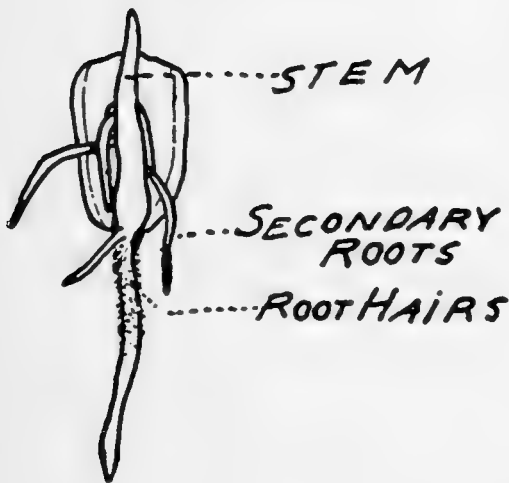
CORN

STAGE I

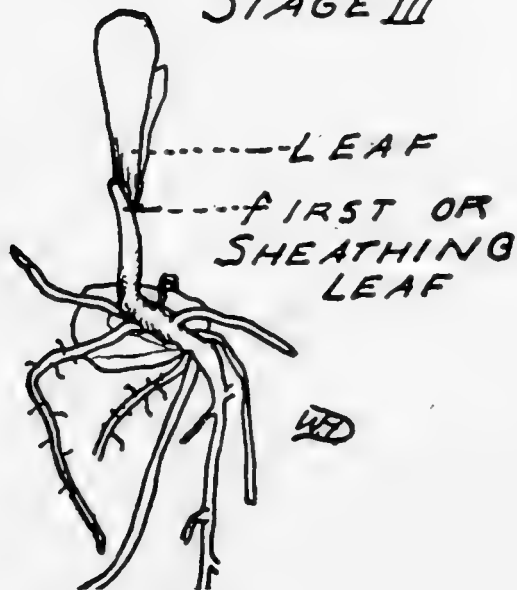


LEAF

STAGE II



STAGE III



STAGES IN THE GERMINATION OF CORN

parts. The starch is always found in the form of small grains in the cells of the seeds. If seeds are crushed and boiled with water, the starch solution will turn blue when a few drops of a solution of iodine are added.

Proteins.— Substances having the same composition as the white of eggs, or as lean meat, are called proteins. They differ from the carbohydrates in that they contain nitrogen. The sticky part of wheat is protein. Beans, peas, and the seeds of other leguminous plants are rich in protein. When substances containing much protein are scorched, they produce an odor similar to that of burning hair, feathers, and wool. This test aids in distinguishing the presence of protein.

Fats.— Fats or oils occur in many seeds, and in flax seed, in cotton seed, and in corn, the fat is found to be considerable. When these seeds are crushed on a piece of paper and slightly heated, the oil spot which appears shows that fats are present.

128. Propagation of Plants.— It is by the formation of seeds that most plants continue both to live from year to year, and to increase in numbers. To propagate means to increase in numbers. Most plants, when left to themselves, die after a few years. The farmer makes it his business to see that, as the old plants die, many new ones are raised to take their place. The chief work of the farmer, indeed, is the propagation of plants.

129. High Grade and Low Grade Seeds.— Seeds of high quality should be:

1. Well matured and not more than two years old.
2. One hundred per cent pure.
3. Of a high weight per bushel.
4. Bright and have a live color and sweet odor.
5. Free from disease, injury, dirt and weed seeds.
6. Well graded.
7. A strong and high germination power.

Important as high grade seeds are known to be, nevertheless, large quantities of inferior seeds are sold in every state. Many farmers demand cheap seeds, thinking it economy to purchase a medium, or low grade, of seed at a little lower price, rather than to pay the increase in cost and secure a high grade, clean, pure, strong seed. It is this unintelligent purchase of low grade seed which is largely responsible for the weed problem in many sections. To aid in the selection of a

KIND OF SEED _____ NAME _____
 AMOUNT _____ WHERE GROWN _____
 PURITY _____ PER CENT GERMINATION TEST _____ PER CENT

IMPURITIES

1. NAME AND NUMBER OF NOXIOUS WEEDS _____
2. NAME AND PER CENT OF OTHER SEEDS _____
3. PER CENT OF INERT MATTER _____

 SEED COMPANY,
 _____ WIS.

LOOK FOR THIS LABEL

Every lot or package of agricultural seeds exceeding one pound in weight, sold or offered for sale in Wisconsin, must bear a label furnishing this information.— *Wisconsin Bulletin 254*.

better grade of seed, State Experiment Stations have State Grain or Seed Laboratories where the analysis of seeds is made free of charge to residents within the state.

130. Seed Selection.— By careful selection of seeds, better crops may be secured, and plants may be improved in many ways. If the best seeds are selected and if these are carefully graded either by hand, by fanning

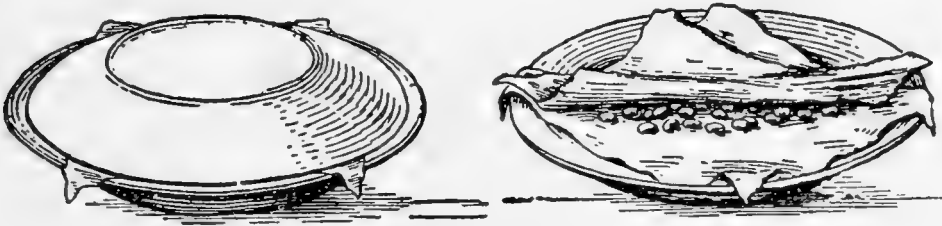
mill, or by grain graders, all the broken, cracked, light, and shriveled seeds will be removed, together with weed seeds, the chaff, and the dirt, and only the best grade of seed will remain to be planted. If such a practice is followed, the quality will be kept up, and the seed will not *run out* as it does where no means are taken to secure only the *best* for seed.

131. Crop Improvement.—Great improvement in corn, in wheat, in other grains, and in potatoes, as well as in many other kinds of plants, has been made in the last decade. This improvement is largely the result of testing seed after it has been harvested. We must go into the field and observe the growing plants and make the selections only from strong, healthy, leafy plants having all the characteristics we desire. These seeds should then be carefully graded and tested, and only those seeds showing a strong and high germination power should be used.

132. Testing Seeds.—The two common methods of testing seed corn, the ragdoll and the sawdust box methods, are described in Chapter IX on corn. We will here discuss only the testing of other seeds.

The Plate Tester.—The simplest way of testing the small grains, clover and grass seeds is to use a plate tester. For this test all that is needed is two tin pie plates or common dinner plates; and two pieces of cotton flannel, or blotting paper cut to fit into the bottom of the plates. Moisten the cloth or paper and place one piece in one of the plates. Count out one hundred seeds and place them upon the wet cloth or paper, and cover with the other cloth or paper. Then cover with the

other plate and keep in a warm place. These cloths or papers should be kept wet and the seeds examined from day to day. The number which sprout determines the percentage of good seed and represents the germination power of the whole sample tested. If only one sample is tested at one time it will be difficult to tell the compara-



SEED-TESTING DEVICE.— *Farmers' Bulletin 408*

tive strength of growth of the different varieties of seeds. It is therefore best to test two or more different samples at the same time, or to test some good seeds of known growing quality at the same time as a new sample, in order to show the comparative strength of growth.

Test two or more different samples of some one kind of seeds, such as wheat, clover, or grass seeds, and determine the germination power and comparative strength of growth of each. If only 50 seeds instead of 100 are used, the percentage is found by multiplying by 2 the number which sprouts. Why?

133. Conditions Affecting Germination.— If the seeds are to sprout and grow well, there are several conditions which must be favorable, such as moisture, temperature, air, depth of planting, fineness of the seed bed, and the nature of the seed case.

The size of the seed determines to a large extent the

depth of planting. Small seeds which produce weak plantlets must be left near the surface of the ground, and they also need the finest seed bed. Many garden seeds should not be planted more than half an inch deep. Peas are sometimes planted several inches deep. Some authorities say, plant seeds four times as deep as their diameter.

In order that seeds may germinate, they must be able to absorb moisture. They will do this better if the soil over them is compact. The danger in this compacting is that a crust may form which may hinder the young plants from breaking through. If the soil is too compact, or too wet, the lack of air will hinder germination, for seeds must have plenty of air. In fields which become covered with water soon after planting, seeds do not sprout.

There is a certain temperature which is best for the sprouting plants. If the soil is colder than this the seeds will not sprout, or will sprout slowly.

QUESTIONS AND PROBLEMS

1. Make a list of seeds used for man's food.
2. Which would be the better balanced ration: one of beans, bread and butter; or one of beans, bread and cheese?
3. Do beans or corn contain the more fat?
4. How would you distinguish between seeds of a good and seeds of a poor quality?
5. Describe what you have ever seen done in the way of seed selection?
6. If one extra day were spent by every farmer each year in the selection and caring for seed corn and the yield thereby increased 2% would it pay?

7. If the annual corn crop of the U. S. were increased 2% what would the increase be worth at 50 cents per bushel?

Consult the latest Yearbook of the Department of Agriculture for the data for Problems 6 and 7.

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Vitality and Germination of Seeds, B. P. I. Bul. 58, 10 cents.

Production of Vegetable Seeds, B. P. I. Bul. 184, 10 cents.

How Seed Testing Helps the Farmer, Yearbook, Sept., 679, 5 cents.

Farmers' Bulletins.

The Adulteration of Forage Plant Seeds, F. B. 382.

Seed of Red Clover and Its Impurities, F. B. 260.

Dodder and Its Relation to Farm Seeds, F. B. 306.

Testing Seeds, F. B. 428.

Propagation of Plants, F. B. 157.

Commercial Clover Seed, F. B. 353.

Hard Clover Seed, F. B. 676.

CHAPTER XIV

PLANT ENEMIES

WEEDS, INSECTS AND DISEASES

134. What a Weed Is.—A weed is a plant growing where it is not wanted. It is a plant so well adapted to the place where it grows that it crowds out more desirable plants.



CANADA THISTLE

The lower figure shows how new plants arise from rootstocks.—*Ohio Agricultural Experiment Station Bulletin 175.*

A plant that is an annoying weed to some farmers, may elsewhere be a cultivated crop. For example, sweet clover is a weed in some localities, and, in others, it is regarded as a valuable crop.

135. Why Weeds are Enemies.—Weeds are enemies because they prevent the best growth of the plants which are wanted. They generally grow fast and vigorously, and deprive the crops of moisture, plant food, and sunlight, and by these means cause decreased crop yields.

136. Classes of Weeds.—Weeds, like other plants, are divided into classes: annuals, biennials, and perennials, according to their habit

of producing seeds and length of life. The chickweed is an example of the first class, and is therefore called an annual. It comes up from the seed in the spring, blossoms in midsummer, produces seeds, and dies the same year. Biennials may be represented by the wild carrot. This plant comes up from the seed, and the first year does not blossom but stores up nourishment. The second year it uses the nourishment to produce seed and then dies. Beets, parsnips, turnips, and such plants as produce fleshy roots the first year are biennials. An example of the third class is the Canada thistle. It comes up from the seed, produces seed after one or more years, and continues to live, perhaps for many years. Perennial herbs die down to the ground in the fall and grow again from the roots in the spring.

Annuals, and How to Kill Them.—Annual weeds follow tilled crops. Some of the common annual weeds are:

beggar tick	jimson weed	shepherd's purse
chickweed	morning glory	wild buckwheat
crab grass	pigeon grass	wild oats
Mayweed	pigweed	wild mustard
fleabane	purslane	
horseweed	ragweed	

If annuals are prevented from going to seed, and if the young plants are hoed or raked up, that is the end of them. It is often well to let the ground lie a week or two after the seed bed has been prepared and before it is seeded, so that the weeds may have an opportunity to sprout. They may then be killed by harrowing the field just before the crop is planted. This gives the

crop a chance to start before a new lot of weeds spring up.

Biennials and How to Kill Them.—Some common biennial weeds are:—

bull thistle
burdock
mallow

meadow salsify
teasel
mullein

wild parsnip
wild carrot



QUACK-GRASS

Ohio Agricultural Experiment Sta-
tion Bulletin 175

It is rather more difficult to get rid of biennials, than of annuals for even though they are mowed off, the roots of biennials are left in the ground and they may send up a stem to produce seeds the second year. They should never be allowed to go to seed, and where they occur on small patches as lawns, they should be killed by cutting off the plants just below the ground.

Perennials and How to Kill Them.—The great majority of troublesome weeds are perennials.

Among these may be mentioned:—

Blue vervain
Canada thistle
catnip
dandelion

oxeye daisy
quack grass
sorrel
wild garlic

wire-grass
plantain
curled dock
Johnson grass

Perennial weeds are the most difficult of all weeds to destroy, because both the tops and the roots must be killed. As with the other two classes, seed production should be prevented. The roots or underground stems should be plowed up or dug up, and either exposed to the sun of summer and the frost of winter, or raked off and burned. The roots may sometimes be starved by preventing any green part to live above the ground. For example, dandelions in a lawn may be killed by cutting off the plant an inch or more below the surface of the ground and pulling out the top. This can be done very rapidly with a spud.

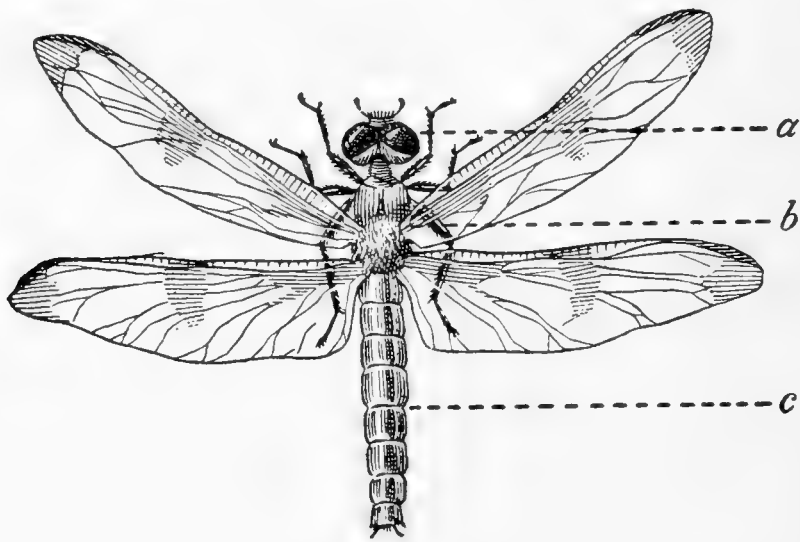
There can be no effective weed control unless fence corners, roadsides, and waste places are kept clean, and the state laws against noxious weeds are more vigorously enforced.

Let each pupil bring into class every noxious weed he can name.

137. Description of an Insect.—An insect is a small animal having six legs and its skeleton on the outside. The body is divided into ring-like parts attached to each other. These are called segments and are in three groups — the *head*, the *thorax*, or chest, and the *abdomen*. The head has attached to it the jaws, feelers, and eyes. The thorax has three parts, to which are attached the six legs and wings. The abdomen is made up of rings and has a row of breathing pores or holes along each side.

138. Life History of Insects.—Insects hatch from eggs as do many other animals. But instead of grow-

ing regularly, they pass through a change, or *metamorphosis*, as it is called, the young being somewhat different from the adult. For example, the young butterfly and moth is a caterpillar having a worm-like body and many legs. This caterpillar, which is called a *larva*, grows rapidly and then passes into a resting stage. In this stage it is inclosed in a rather hard shell often covered with a silk case called a *cocoon*. It is quiet and



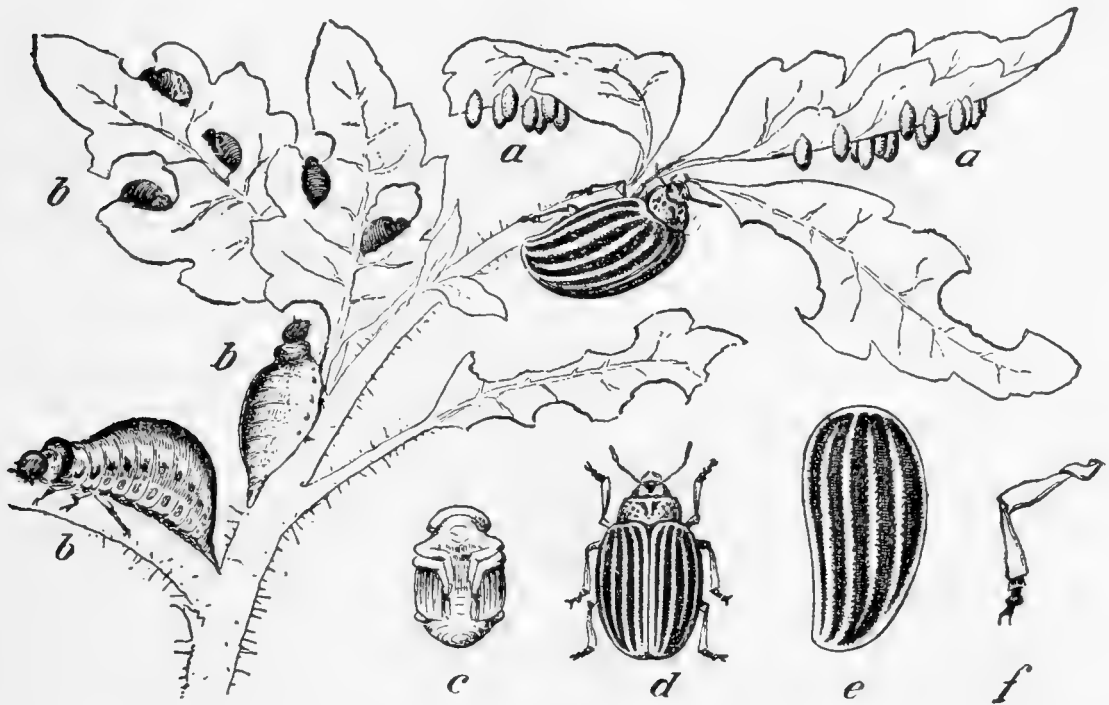
TYPICAL INSECT

a, head with eyes and mouth parts; *b*, thorax, with legs and wings;
c, abdomen, showing segments

eats nothing. It may occupy this stage for days, weeks, or even all winter. After a time it comes out as an adult insect. It is in the larval stage that many insects do their harm by eating vegetation and foliage.

Some insects, as the squash bug, the grasshopper, and the cricket, do not pass through a complete change, but have, when hatched, the same form as the adult except that their wings are wanting. Such insects *molt*, or shed their skins, several times; and after each molt their wings, and bodies are larger than before.

139. **Classification of Insects.**—In agricultural discussions, insects are divided into two groups, *cutting* and *sucking* insects. Cutting insects bite off parts of the leaf or plant, and devour them. Sucking insects



POTATO BEETLE

a, eggs on underside of leaf; *b*, larva that eats the leaves; *c*, pupa; *d*, perfect insect; *e*, wing cover; *f*, leg

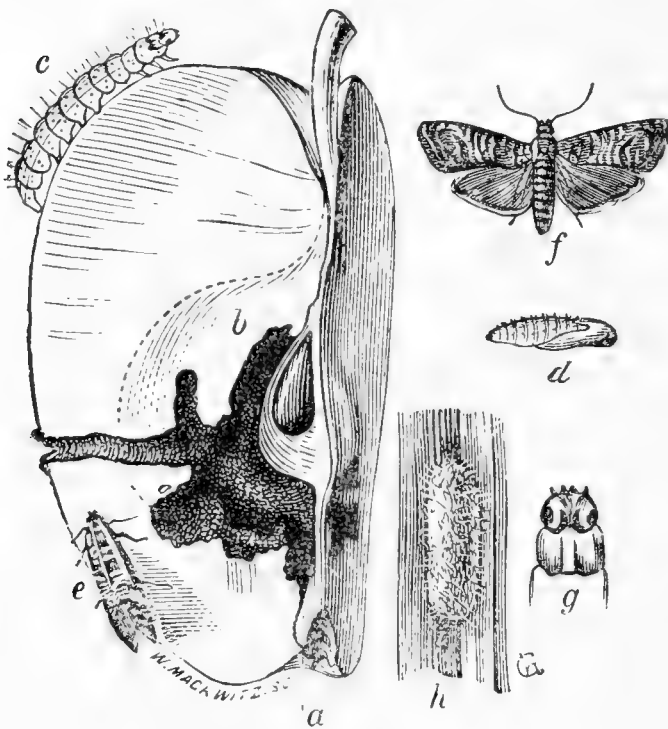
insert their long, slender mouth parts into the plant and suck the juices from it.

Some Common Cutting Insects.—Examples of cutting insects are the larvæ of:

codling moth	potato beetle	tussock moth
canker worm	army cutworm	June-beetle
cabbage worm	gypsy moth	tent caterpillar

The *Codling Moth*, an apple tree pest, is one of the most injurious of insects. The adult is a small gray moth about one-half an inch long. It lays its eggs on

the leaves or on the immature apples just as the petals of the apple blossoms fall, or later, if it is the second generation. The larvæ hatch, eat their way into the



CODLING MOTH

a, the entrance hole; *b*, the burrow; *c*, the larva; *d*, the pupa; *e*, moth at rest; *f*, moth with wings spread; *g*, head of larva; *h*, cocoon containing pupa.

young apple, which may soon fall, if it harbors the first generation. Afterwards the larvæ work their way out of the apple and crawl into a crevice of the bark of the tree or similar place, from which they emerge as adult insects. The larva is the white worm so familiar in apples, often called the apple worm.

The *canker worm* is found on fruit and shade trees. The adult is a small ash-colored moth, the female of which is wingless. The larva is often called the measuring worm because of its method of traveling by looping its body. The eggs are laid in patches on the bark of a tree. The larvæ will strip the foliage of the tree with great rapidity. After the worms have matured, they swing themselves down by a silken thread, burrow in the ground, and there go into the resting state. The last brood stays in the ground over winter.

The *cabbage worm* is the larva of the well-known white

cabbage butterfly. It is greenish white in color, tapering at each end, and covered with fine white down. The eggs are laid on the leaves of the cabbage and similar plants. In ten days they hatch, and the larvæ feed on the leaves about three weeks. The resting stage of the first brood lasts about two weeks and the brood is generally hatched in May. The second brood is hatched in July.

The *potato beetle* is well known. In the Central States there are generally three broods, the last one remaining in the ground over the winter in the resting stage. The larvæ of the two broods feed about twenty days each, and remain quiet in the ground ten or twelve days. This insect is discussed more fully in Chapter XII.

Some Common Sucking Insects.— Examples of sucking insects are:—

Plant lice	San José scale	Cottony maple scale
Chinch Bugs	Oyster-shell scale	

Plant lice are small, green, oval insects which live upon many different plants from which they suck their nourishment. They are most commonly found upon leaves or young, green stems, but some varieties attack the roots of plants. Some are protected by a thin, waxy or downy scale-like covering, from which they get the name of scale insects.

The *chinch bug* is less than a quarter of an inch long, but it is said to cause more damage than any other known species of insect. It is brown in color, with

white fore wings, each having a dark spot near the middle. These insects are the greatest enemies of the wheat



CHINCH BUG
(ENLARGED)

crop. They sometimes attack corn also, "fairly blackening the stalks with their bodies." Almost as harmful to the wheat crop as the chinch bug, is the Hessian fly which is described in Chapter X.

The *San José Scale* appears as small, gray, circular specks about the size of a pin head, on the tender bark of many fruit and shade trees. Because it is so small it is difficult to

detect it. The insect passes the winter beneath the scale in an immature stage. As the sap rises in the spring, the insect begins to extract it by means of a sucking tube, and soon matures. In May or June minute yellow specks may be seen wandering over the surface of the bark. These are young scale insects produced by the adult female. They settle down, after a period of a few hours or a day, extract the sap and begin to secrete an armor-like scale.

The *oyster-shell scale* is considerably larger than the *San José Scale*. It is about one-eighth of an inch long. It has an elongated shape, is convex and is irregular. It has a dark brown or gray color and its habits of growth, of producing young, etc., resemble the *San José Scale*.

The *cottony maple scale* may be recognized easily by its cottony masses. This insect does great damage to soft maples, basswood, and box-elder trees and to many

shrubs. The adult passes the winter in a small oval scale about one-sixteenth of an inch long. In the spring, when it begins to develop eggs and the cottony, wax-like secretion, it rests upon one side. The eggs are scattered

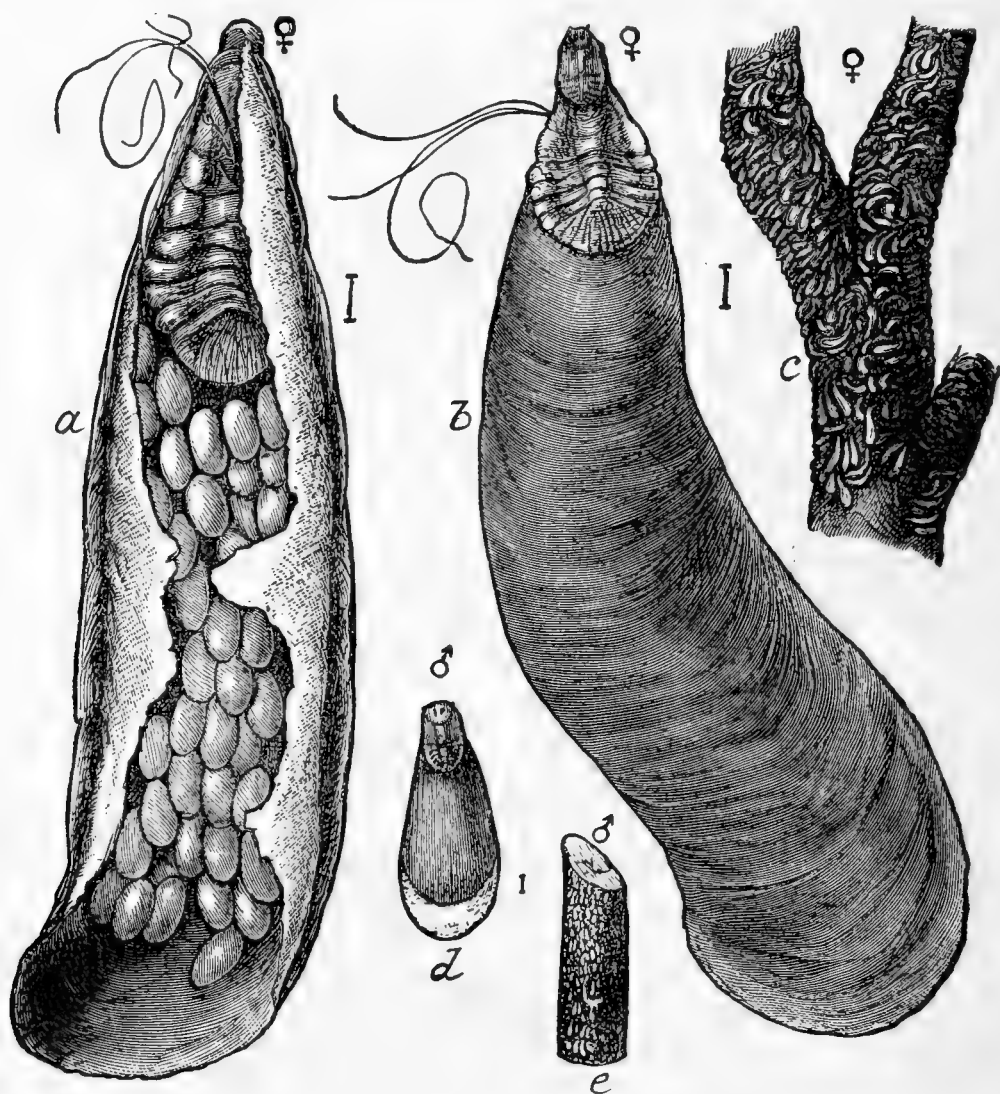


DIFFERENT STAGES OF THE SAN JOSÉ SCALE (Enlarged five times).
Virginia State Crop Pest Commission Bulletin 1904; Massachusetts Department of Agriculture Circular, No. 6.

about in the cottony mass. The young resemble those of the other scale insects.

140. Insect Control.—Cutting insects are exterminated by spraying the foliage they devour with poisonous mixtures, so that the insects take the poison in their

food. Sucking insects are destroyed by covering their bodies with some substance which kills by contact. Good standard insecticides — substances which kill insects — for cutting insects, are arsenate of lead, and



OYSTER-SHELL SCALE

a, under side of female scale, showing eggs; *b*, upper side of same, both much enlarged; *c*, female scales on a branch, natural size; *d*, male scale, much enlarged; *e*, male scales on branch, natural size. The fine lines to the right of *a*, *b*, and *d* show the real length of the scales.—Howard, U. S. Dept. Agr. Yearbook, 1894; Massachusetts Department of Agriculture Circular, No. 6.

Paris Green. For sucking insects, the most common remedy is kerosene emulsion. Formulæ for the various insecticides will be found in Chapter XX.

141. Nature of Plant Diseases.—The third great enemy of the farmer's crop is disease. Plant diseases are caused by bacteria, molds, and other fungi. These organisms belong to a group of low vegetable forms which, not having any green coloring matter or chlorophyll, are obliged to get food from some higher plant which has chlorophyll.

These low forms of plant life grow mostly from spores, minute one-celled structures, which take the place of the seeds of higher plants; sometimes they multiply by dividing into two or more parts. These spores are so small and so light that they may easily be carried by the wind. Corn smut and wheat rust are familiar examples of these lower plants. When a mass of corn smut is broken, it sends out a great cloud of brown dust; each particle of brown dust is a spore, which may produce the disease in a corn plant the next year. Because of the vast number of spores, these organisms are multiplied or propagated with great rapidity. The brown and rusty spots on the stubble of wheat, oats, grasses, etc., are masses of spores produced by the rust disease affecting the plants.

142. Some Common Plant Diseases and Their Treatment.—Some of the most familiar plant diseases are:—

fire blight
oat smut

wheat rust
potato scab

potato blight
corn smut

Fire blight gives to the end of pear and apple tree twigs the well-known blackened appearance. It is caused by bacteria growing in the inner layer of the

bark. There is no cure for fire blight. The twigs should be cut off and burned.

The *oat smut* is a common fungus which does much damage to the oat crop every year. The loss of oats due to smut amounted to 4 per cent. of the total crop grown in the United States in one year and the value of this was over \$16,000,000.00. In some states the annual loss is 10 per cent. or more of the total crop. The disease is spread through the seed planted. The spores find a good lodging place under the hull, and in the ground they begin to grow about the same time that the oat seed does. The spores form small threads which enter the young plant through the breathing pores. The disease checks the growth of the plants, reduces the yield, and often destroys the grain, replacing the contents of the grain with a black mass of spores. The spores on the seeds may be killed by treating the seed oats with a solution containing one pint of formaldehyde or formalin in thirty gallons of water as described in Chapter X.

Wheat rust appears as rusty and brownish streaks on the stubble of wheat plants. The spores are not spread by the seed, and rotation of crops is the only common means of checking the disease.

The *mildews* which attack the grape vines, lilac bushes, and many other plants, are common fungi which grow partly within the leaf, and partly upon its surface. These can be prevented by spraying the foliage with Bordeaux mixture.

Potato scab is very familiar to all farmers and housewives. This disease is caused by a fungus which grows on the skin of the potato causing the rough, irregular

areas. The spores live on the seed potatoes and in the ground. The remedy is to soak the seed potatoes in the formaldehyde solution (see Chapter XII), and rotate the crops.

Potato blight affects the leaves of the plant and sometimes the tuber in the ground. It causes the leaves to turn brown and brittle, and in time kills the plant. It may be prevented by constant spraying with Bordeaux mixture. Spraying should be started when the plants are about six inches high. (See Chapter XII.)

QUESTIONS AND PROBLEMS

1. Why is it more difficult to exterminate a perennial weed than an annual?
2. Name some of the most noxious weeds in your community?
3. Why are Canada thistle and dandelion hard to keep in check?
4. Which is better farming, to prevent weeds or to kill weeds?
5. Is it good practice to allow weeds to cover the ground after the garden crops are gathered?
6. Which is better, to kill a moth or a larva? Why?
7. How does a robin locate a grub or worm in the ground?
8. What injurious insects have you seen in your community?
9. Have you seen any trees infected with San José or Oyster shell scale? If so, describe any effects you notice upon the tree.

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Rusts of Grains in U. S., B. P. I. Bul. 216, 15 cents.

Potato Diseases, Bul. 64, 15 cents.

Powdery Dry-rot of Potatoes, B. P. I. Cir. 110, 5 cents.

The Weed Problem in American Agriculture, Year Book, Sep., 732, 5 cents.

Farmers' Bulletins.

Preventing Wheat and Oat Smut, F. B. 250, 507.

Potato Tuber Diseases, F. B. 544.

Collecting and Preserving Insects, F. B. 606.

The True Army Worm, F. B. 731.

The Boll Weevil, F. B. 512.

The Chinch Bug, F. B. 657.

San José Scale, F. B. 650.

Oyster Shell and Scurry Scale, F. B. 723.

Gypsy and Brown Tail Moths, F. B. 564.

The Hessian Fly, F. B. 640.

Wireworms, F. B. 725.

Common White Grubs, F. B. 543.

House Ants, F. B. 740.

The Common Cabbage Worms, F. B. 766.

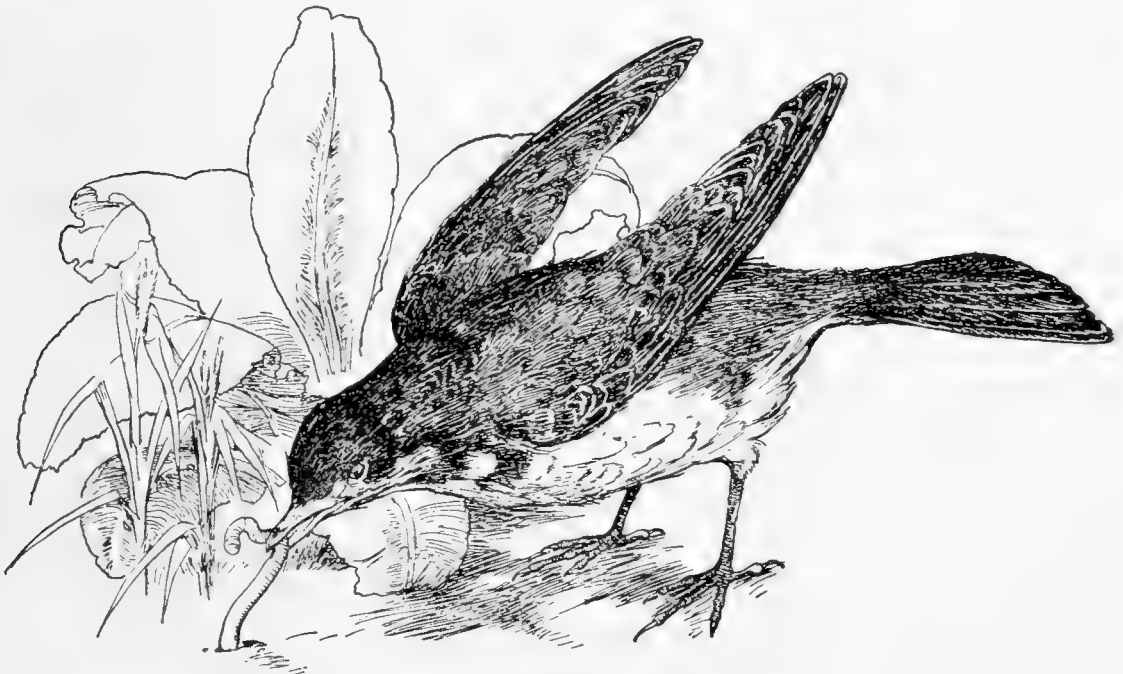
Grasshopper Control, F. B. 747.

Cereal Smuts and Seed Disinfection, F. B. 939.

CHAPTER XV

THE FARMER'S FRIENDS: BIRDS, TOADS, BEES

143. **Birds and Their Food.**— While a large part of the farmer's work consists in fighting insects, weeds, and other injurious things, he has some valuable friends who work with and for him. Probably the most valu-



ROBIN

able are the birds. They aid the farmer by eating insects and seeds of weeds.

Young birds grow rapidly and require a great amount of food. Many of them are fed mostly on insects. It has been estimated that a pair of sparrows will carry more than three thousand caterpillars to their nest in a

week. A young robin, kept in captivity, was fed sixty earthworms a day, and an observer claims that a pair of young European jays were fed a half million caterpillars in a single season.

144. Useful Birds.—Birds that help the farmer may be divided into three groups. First, those that live



KINGBIRD

chiefly, or prefer to live, upon animal food, such as insects in their various stages. Among these birds may be mentioned the

robin	kinglet	kingbird
thrush	scarlet tanager	pewee
bluebird	bobolink	black-billed cuckoo
phoebe	wren	woodpecker

Second, those that eat both animal and vegetable food. Among these may be mentioned the

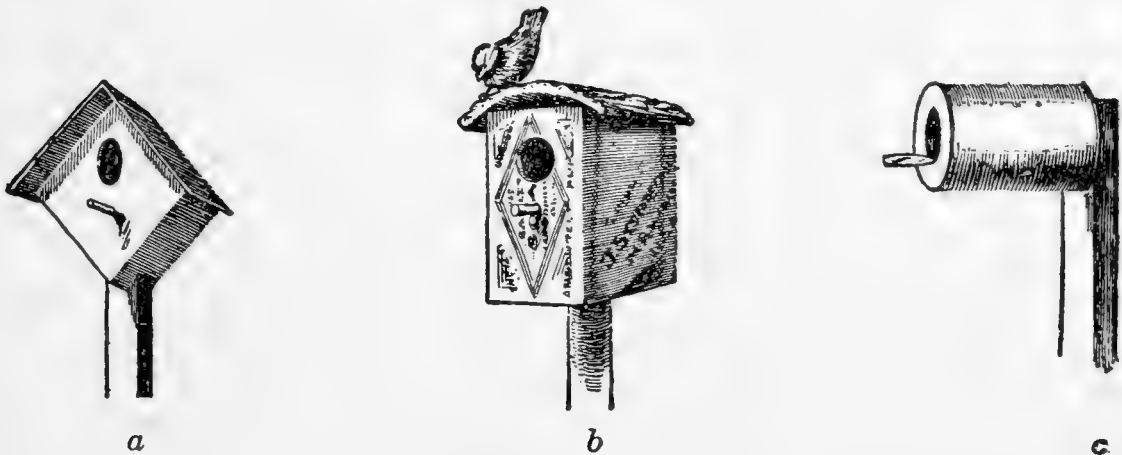
catbird	chipping sparrow	quail
brown thrush	marsh robin	blue jay
white-bellied nut-hatch	purple grackle	meadow lark

Third, those that prefer a vegetable diet of seeds. Among these may be found the finch, thistle bird, indigo bird, and mourning dove.

It is not to be understood that hard and fast lines can be drawn among the birds in regard to their feeding habits. Birds have their preferences, but the season of the year and the abundance or scarcity of a given food determine to a large extent the kind of food eaten.

Watch the various birds and learn their feeding habits. It is often possible to get into a position where the feeding of the young may be noted.

145. Attracting the Birds.— In order that we may have more birds living about our homes, to help destroy



BIRD HOUSES

a and *b*, made from boxes; *c*, made from a tin can

insects and give us pleasure by their songs and beauty, we must provide them with conditions which are favorable to their ways of life. Birds must find suitable

places for building their nests. The planting of trees and shrubs is the very best way of attracting birds. Clumps of shrubbery will afford excellent nesting places for shy birds, while the crotches of trees will be used by robins and many others. The boys can easily make bird houses for wrens, martins, bluebirds, and chickadees. Wrens will often occupy a tin can or a small pail which has been fastened to a board with the closed end up and a small hole made in the side.

The matter of food supply is a more pressing question with the birds than with human beings, for they cannot store away food to any great extent. During the summer days there are insects in abundance and often seeds and fruits. In the winter the birds that remain have difficulty in finding food. Then it is that a piece of suet or other fat meat fastened to a tree, or some cracked nuts placed in a shallow box on a tree, will serve to call the chickadees, nuthatches, hairy woodpecker, downy woodpecker, brown creeper, blue-jay, and English sparrow.

Water is essential to bird life. Often our feathered friends suffer in the summer time because they cannot readily find places to drink and bathe. It is an easy matter to place a pan or shallow dish partly filled with water on a post out of reach of cats. Most of you will be surprised at the number of bird visitors that will come every day to seek a drinking fountain.

If stray cats of the neighborhood can be disposed of, this will serve as a very valuable way of increasing the number of birds about our homes. Children should be taught to care for the birds and not to molest them.

146. Toads and Frogs.—The toad can lay no claim to beauty, but there is no more useful animal of its size. One of the most amusing pastimes is to catch rose bugs and put them down in front of a toad. The bugs suddenly disappear. The toad's tongue is attached at the front of its mouth. It is covered with a sticky substance, and can be snapped out like a whip-lash. There seems to be no limit to the number of bugs a toad can eat, so that toads exert a great power for good in ridding our gardens of destructive insects. The eggs of toads are laid in the water, in strings of a jelly-like substance. The tadpoles that are hatched from the eggs are useful in devouring the refuse matter in the pond. Frogs perform the same service.

147. Importance of Bees.—Bees, and especially the honey bees, are other important friends of the farmer and they render him an invaluable service in pollenizing the flowers of fruit trees, of small fruits, and of many garden and field crops. But in addition to this very valuable and important service, they give him also a crop of honey worth about \$20,000,000 a year in the United States and a crop of beeswax which has been estimated to be worth annually \$2,000,000.

148. Food of Bees.—Bees get all their food free of expense to the farmer; and though bees do require some care, it is generally not expended in feeding them. Among the flowers on which bees feed may be mentioned the clovers, buckwheat, locust, basswood, milkweed, daisies, and other flowers, blossoms of fruit trees and shrubs, and cucumber and melon blossoms. In some localities, horsemint is an important bee flower.

149. A Colony.— Each colony of bees contains a queen, from ten thousand to fifty thousand workers, and a few hundred drones. The queen lays all the eggs. The workers are imperfectly developed females, and



BEES

a. drone; *b.* queen; *c.* worker

gather honey, furnish wax and beebread, make the combs and fill them, and also feed the young bees. The drones are the male bees and do no work.

150. Development of Bees.— The queen lays one egg in each cell of the brood chamber; out of it hatches the young bee or larva. This little insect appears like



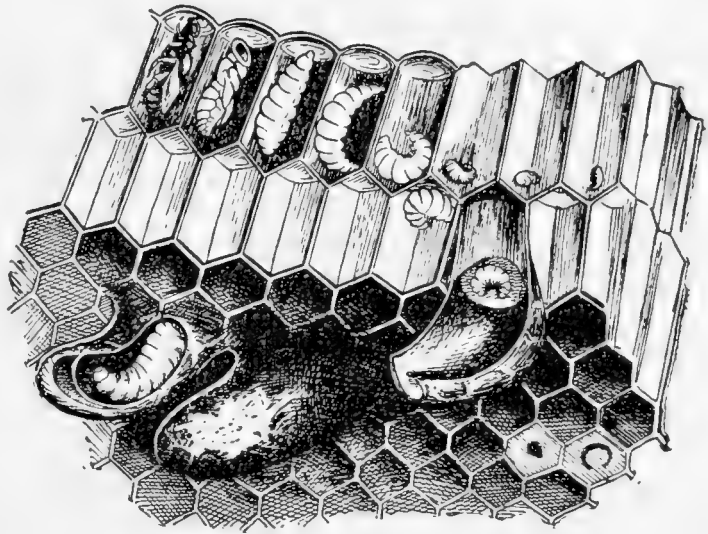
DIAGRAM SHOWING A
BEE GETTING HONEY

a worm, and gets only what is fed to it. After a few days, the cell is sealed up by the workers and the larva spins a silken covering or cocoon about itself. Then after about three weeks, it comes out, an insect with wings. The queen lays her eggs in three kinds of cells. Out of the smallest cells come the workers. From the next size come the drones, and in a few of the largest cells are laid eggs that are to produce queens.

151. Swarming.— At certain times the bees, or most of them, in company with the queen, having their

sacks well filled with honey, rush forth from their hives and swarm, as we call it. After circling about in the air for a while they generally settle on a branch of a tree or brush near by. The bee keeper must then get them to settle in a new hive. Sometimes the hive is carried to the tree

on which the bees have alighted, and if they are low enough they can be gently brushed in. More frequently, the branch is cut off and carried to the hive, where the bees are gently shaken to the ground before the



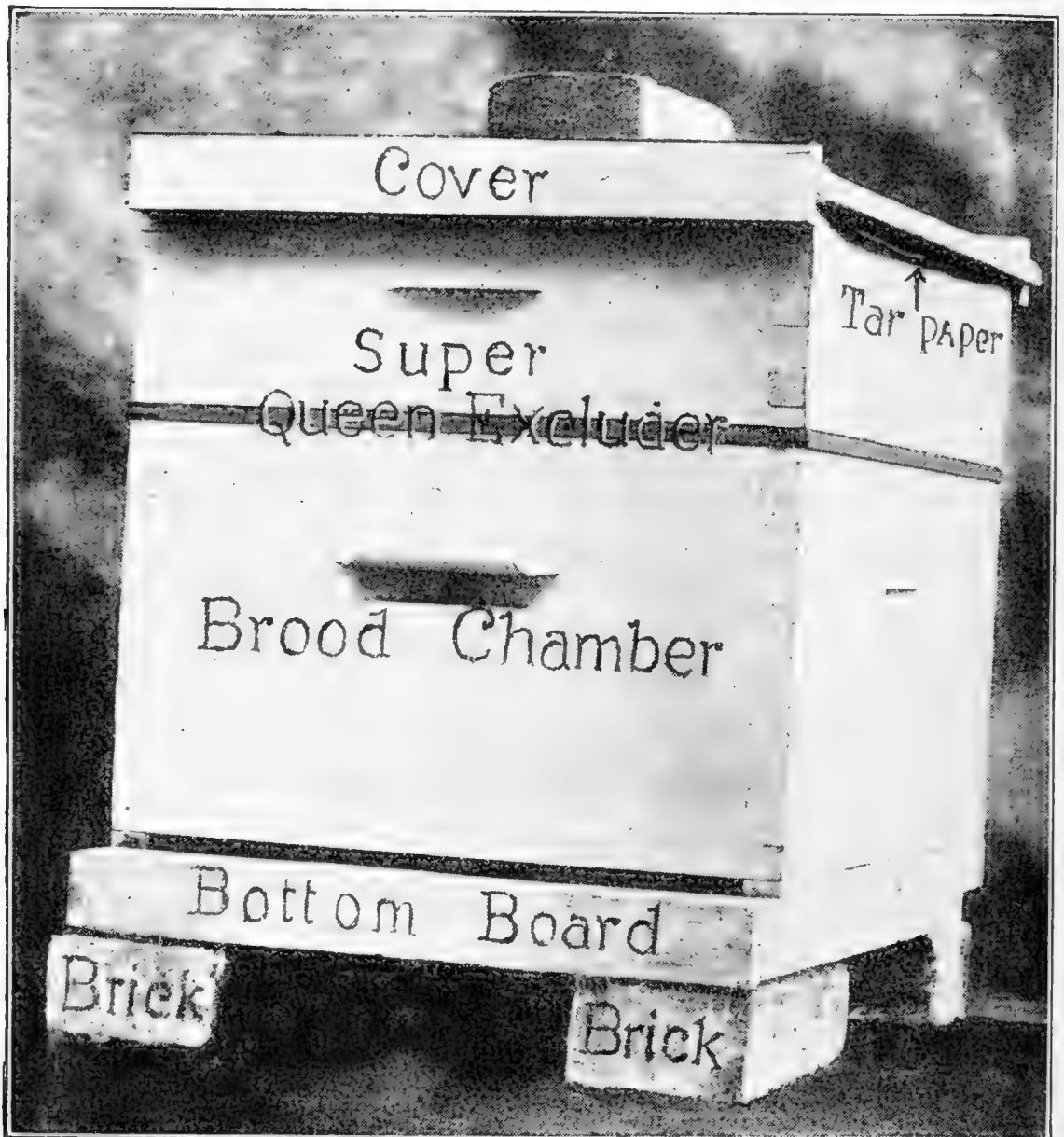
CELLS CONTAINING EGGS, LARVAE, AND PUPAE
OF THE HONEYBEE

The lower large, irregular cells are queen cells.
— *Benton*

new hive and they find their way in. If then a little new or unfilled comb is found in the hive, something for them to go to work on, they will settle down and make it their home, and get to work.

152. The Bee Hive.— The common bee hive consists of a base or bottom board upon which rests the large lower part of the hive called the brood chamber. The brood chamber generally contains ten movable brood-frames. These are about $9\frac{1}{8} \times 17\frac{5}{8}$ inches and are hung from the top so that they are separated by a little space from the sides and bottom of the brood chamber, and also from each other, so that the bees can freely move about between the frames. In the cells of the

brood chamber the queen lays the eggs. The upper chamber of the hive is commonly called the super. It



FRONT VIEW OF HIVE

Note the bricks for raising the hive four inches from the ground. On the bricks is the bottom board, then the brood chamber, and between this and the super, the queen excluder. In the super is stored the surplus honey. Beneath the hive cover is a strip of tar paper or roofing-felt and on the top of the cover is a brick for weighting it down.—*University of Missouri Bulletin 138.*

is separated from the brood chamber by a thin partition called a *queen excluder*. This queen excluder has open-

ings just large enough for the workers to get through; but prevents the queen from getting up in the super and depositing eggs there. In the super, there are generally six movable frames called *section-holders*, each of which accommodates four *sections* or *combs*, $4\frac{1}{4} \times 4\frac{1}{4}$ inches, which when filled usually hold one pound of honey. The frames in the super and the combs are so made and supported that the bees can easily get about and do their work — that is, build the cells and fill them with honey.

Above the super is the top or cover of the hive. Such standard hives as are here described may be purchased very reasonably and it never pays to attempt to make them.

QUESTIONS AND PROBLEMS

1. Name the birds you have observed and know.
2. In what seasons of the year do the birds destroy the greatest number of insects?
3. Describe what you have done to attract birds.
4. Are the game laws in your state designed to protect the farmers in any way?
5. How does a robin supply food for its young?
6. How does a woodpecker locate a grub beneath the bark of a tree?
7. What is the difference between a frog and a toad?
8. Counting 40 birds to a square mile, in the summer, how many birds are there in your state?
9. Allowing 50 insects a day for 120 days of summer, and assuming that 60% of the birds in your state are insect eating birds, how many insects are destroyed in this period?

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Bird Day in Schools, Bio. Cir. 17, 5 cents.

How Birds Affect the Orchard, Yearbook, Sept., 1900, 5 cents.

Open and Closed Seasons for Game, Bio. Cir. 43, 5 cents.

Plants Useful to Attract Birds, Yearbook, Sep., 504, 5 cents.

Does it Pay to Protect Birds? Yearbook, Sep., 443, 5 cents.

Birds That Eat Scale Insects, Yearbook, Sep., 416, 5 cents.

The Crow and its Relation to Man, Dept. Bull. 621, 15 cents.

Food Habits of Swallows, Dept. Bulletin, 619, 5 cents.

Farmers' Bulletins.

Common Birds of the Farm and Orchard, F. B. 513.

Bird Houses and How to Make Them, F. B. 609.

Food of Common Birds, F. B. 506.

How to Attract Birds, F. B. 621, 760.

Birds of Southeastern U. S., F. B. 755.

The Grosbeaks, F. B. 456.

Bees, F. B. 447, 397.

Comb Honey, F. B. 503.

Outdoor Wintering of Bees, F. B. 695.

How to Attract Birds in Northwestern U. S., F. B. 760.

Care and Management of Canaries, F. B. 770.

How to Attract Birds in East Central States, F. B. 912.

CHAPTER XVI

GARDEN CROPS

It is essential that all vegetables be grown rapidly, to be tender and delicate. When they grow too slowly they not only become tough and fibrous but they also lose their good flavor. Some vegetables prefer cool weather, and others, warm weather; when these are planted out of season, it is usually impossible to get vegetables of a good quality. This is why peas, spinach, lettuce, and radishes, which are plants preferring cool weather, cannot be successfully grown during the hot summer months.

153. Classes of Vegetables.—Garden crops may be divided into two classes, the *hardy* and the *tender*. The hardy vegetables can stand light freezing and are not killed by frost; therefore, they may be planted early, some of them as soon as the frost is out of the ground in the spring. The tender crops are killed by frosts, and therefore, should not be planted until all danger of frosts is over. Below is a classified list of the common vegetables:

HARDY		TENDER	
Beets	Parsley	Beans	Peppers
Brussels	Parsnips	Lima Beans	Potatoes
sprouts	Peas	Cantaloupes	Pumpkins
Cabbage	Radishes	Celeriac	Squash

HARDY		TENDER	
Carrots	Spinach	Celery	Sweet Pota-
Cauliflower	Salsify	Corn	toes
Endive	Swiss Chard	Cucumber	Tomatoes
Kale	Turnips	Egg-plant	Watermelons
	Lettuce	Onions	

154. Companion Crops.—Whenever slowly growing and late maturing crops are planted in hills, some sort of quickly growing and early maturing crop may be sown in the rows between the hills. This process not only economizes space and labor, but also gives a greater variety of vegetables on any given area. Another way of growing a companion crop is illustrated when an additional row of some early vegetable is planted between the rows of a late maturing crop, the rows of which are, when mature, three or more feet apart.

Radishes, green onions, spinach, and lettuce may be planted in rows between the corn, potatoes, tomatoes, melons, cucumbers, etc., and will be harvested before the spaces between the rows are needed by the later crops. These early crops may also be planted in the same rows with all crops which are planted in hills, and the early crops will be harvested before either they or the hill crop is in any way affected by their having been planted together.

155. Succession Cropping.—In small gardens, the land should be continuously cropped, and when one row of vegetables is harvested, another should take its place. This is the meaning of succession cropping, and to make a success of this, one must have a thorough knowledge of the various kinds of vegetables and must know

how long it requires each kind to mature, so that when an early maturing kind is removed, some other vegetable which will mature, may be planted in its place.

The following list contains the vegetables which may be followed by another crop, and sometimes, by two other crops:

Radishes	Kale	Early potatoes
Lettuce	Peas	Early corn
Spinach	Beans	Early turnips

The following list contains vegetables which usually require the whole season, and, therefore, may not be followed by other crops:

Tomatoes	Parsnips	Melons
Late potatoes	Salsify	Late celery
Late cabbage	Egg-plant	Late endive
Parsley	Peppers	Swiss chard

Examples of a three crop succession are:—

Early green onions, followed by beans, followed by late radishes.

Early radishes, followed by peas, followed by late spinach.

Early spinach, followed by radishes, followed by late beans.

Examples of a two crop succession are:—

Early peas followed by tomatoes.

Early potatoes followed by late cabbage.

Early beans followed by endive.

156. Hotbeds and Cold-Frames.— Hotbeds and cold-frames are used to start certain crops like tomatoes, egg plant, cabbages, etc., earlier than they could be planted in the open ground. Quite often seed flats,—

shallow boxes 2 to 3 inches deep, are used in place of hotbeds or in connection with them. These boxes may be placed near a window in any warm room and all garden crops requiring an early start may be successfully raised in them. The soil should be rich and should contain considerable humus and coarse sand, so that air may circulate well and the free water drain off readily. The soil in the hotbeds, cold-frames, and seed flats, should be watered frequently and never allowed to dry out.

Making a Hotbed.—The ideal location for a hotbed is in a place where it will have a southern exposure and, at the same time, be protected from the cold north winds. The south side of some building or fence is an ideal place.

A pit one and one-half to two feet deep and having the same size as the frame, should be excavated, preferably in the fall. The frame should be made of boards one inch thick, should be about 12 inches high on the north side and six inches on the south side, and large enough for the sash or covering. This will give a slope to the south. This frame should be fastened by corner stakes over the pit and might, if desired, extend to the bottom of the pit. A few days before the first seeds are to be planted a layer about one foot deep of fresh or slightly heated horse manure should be put into the pit and thoroughly tramped down. After this manure is put in, a layer of good soil about six inches deep should be added. This soil should be kept moist and after it has passed through its first heating stage and cooled a little, a condition which may be determined by

putting the hand into it, the seeds may be planted. Manure and dirt are usually banked about the outside of the hotbed to aid in keeping the hotbed warm. The heat comes from the fermenting or decomposition of the manure. In the hotbed the seedlings must be given air and sunlight and must be kept from becoming either too warm or too cold. The temperature may be regulated both by sprinkling, and by raising and lowering the sash or cloth covering used to cover the bed.

Truck gardeners and many farmers often plant seeds in flats and then place these flats in the hotbeds, using a little less soil. The flats are more easily handled and are very convenient in removing the seedlings to the field or in taking them to the market to be sold. In the flats the seedlings are not disturbed as they would have to be had they been planted directly in the hotbed.

Cold frames are similar to hotbeds, except that they never contain any manure. They cannot be used as early in the spring nor as late in the fall as hotbeds can.

157. Seed-Beds.— Sometimes seeds are started in a protected place in the garden, where the soil is rich, without any covering whatsoever. Such spots are called seed-beds. Sometimes, however, the seed-beds are protected from the hot sun by having a cloth stretched over them for shade. These seed-beds are used only for the production of late seedlings.

158. Annual Flowering Plants.— The seeds of many annual flowering plants are very small, and if planted directly in the garden, the seed bed should be unusually well prepared and the seeds barely covered.

The soil should never be allowed to dry out until the plants have made a good start. Most of these plants may be started in seed flats in February or March, and these seed flats may be kept in hotbeds or in any warm room.

A few common annuals are: asters, cosmos, marigold, petunias, candytuft, nasturtiums and sweet peas.

159. Biennials.—The biennial flowering plants rarely flower during the first year of their life, but during the second year, after which they die. After they have flowered, many seeds from biennials fall around the base of the plants, and from these seeds new plants grow, so that often throughout successive years seeds do not need to be planted. This fact leads many to believe that many plants which are biennials are perennials.

A few common biennials are: —

- | | |
|----------------------|---------------------|
| 1. Sweet William | 3. Pansies |
| 2. Hollyhocks | 4. Canterbury bells |
| 5. Oriental Poppies. | |

160. Perennials.—The perennial flowering plants are those which, when once started in a rich soil, will live for many years. They should be mulched with light, strawy manure during the winter. This mulching not only protects the plants from freezing, but also acts as a good fertilizer, and the fine material the mulching leaves loosens the soil.

A few common perennials are: —

- | | |
|-----------------|-------------|
| 1. Columbine | 3. Larkspur |
| 2. Shasta daisy | 4. Foxglove |

- | | |
|---------------|-----------------|
| 5. Phlox | 8. Peonies |
| 6. Gaillardia | 9. Iris |
| 7. Lillies | 10. Snapdragons |

QUESTIONS AND PROBLEMS

1. How large is your home garden?
2. What crops were raised in your home garden last year?
3. Assuming that each vegetable raised last year in your garden would cost at the store from 1 to 5 cents for each grown member of the family for each meal, what would the approximate value of the crops raised last year in your home garden be?
4. Make a list of the most nutritious vegetables.
5. What vegetables are most suitable for winter storage?
6. Look up in a physiology the special value of many of the fresh vegetables.
7. Figure the cost of making a hotbed 6' x 3' assuming that you have some old sash and lumber.
8. What would be a fair value of the spring crop that could be raised in the above hotbed?

Farmers' Bulletins.

School Exercises in Plant Production, F. B. 408.

Potato Culture, F. B. 35.

Okra, Its Culture and Use, F. B. 232.

Frames in Truck Growing, F. B. 460.

Cabbage, F. B. 433.

Sweet Potatoes, F. B. 548, 324.

Asparagus Culture, F. B. 61.

Celery, F. B. 282.

Cucumbers, F. B. 254.

Annual Flowering Plants, F. B. 195.

Tomatoes, F. B. 220.

Tomato Growing in the South, F. B. 642.

Cabbage Diseases, F. B. 925.

Asparagus, F. B. 829.

Saving Vegetable Seeds for the Garden, F. B. 884.

CHAPTER XVII

HOME GARDENS

The experience gained by the successful conducting of a good garden, the skill gained in its management, and the new insight into the natural processes of growth and development of plants, such work gives will have a greater value to the student of agriculture than any knowledge he could gain in any other way.

161. Location of the Garden.— The garden should be located in a sunny place, preferably sloping to the south, and convenient to the house. It should be of such a size that it may be well and thoroughly cared for; on a farm it should be planned so that it may be worked largely with horses and horse tools. A garden's nearness to the house makes it possible for its manager to spend odd time in caring for it.

162. The Garden Soil.— The garden soil should be well drained, sweet, and rich. In it, much plant food should become available, so that the crops may grow rapidly. The manure applied in the spring should not be of a coarse, bulky nature, but should be well rotted and well worked into the soil. A light soil is preferable, and always makes the best garden spot. However, by proper treatment and cultivation almost any soil may be made suitable. If possible, the soil should be manured and plowed or spaded deeply in the fall, and left in a

rough condition during the winter. This treatment will make the soil light and mellow in the spring.

163. Value of the Garden Plan.—Sometime during the winter, or early spring, one should carefully measure the ground available for the garden and make an accurate plan of it, drawn to some scale. A good garden plan not only gives one a definite idea of just what there is room for in the garden, but it also enables one to plan accurate space for just the vegetables and the quantities of them, he wishes to grow. From the plan, one can readily make out an economical seed order, and save much time in planting the seeds.

164. Essentials of a Good Garden Plan.—A good garden plan should show the garden laid out not in square beds or little patches as was formerly the practice, but in long, straight rows. It should show the proper number of rows and the proper distances between these rows and should include a definite allotment of space for all the vegetables and flowers one wishes to grow. The perennials should be at one side or at the rear of the garden; the tall plants, where they will not interfere with the growing of other crops. The plan should be true to the scale used and should provide for a succession of crops. It should also provide that crops, requiring the same kind of cultivation, and having about the same length of growing season, be planted in the same or adjoining rows. A plan for any given season, when compared with the plan for the previous season, should also show a rotation of crops.

Plan of a Garden.—A suggestive plan for a garden is shown on the next page.

1'	Onion Sets	follow with beans
1 ½'	Beets	follow with lettuce
1 ½'	Radish and Lettuce	follow with parsnip
1 ½'	Spinach	follow with beans
2'	Swiss Chard	
2'	Peas	follow with cabbage
2 ½'	Peas	follow with tomatoes
2'	Beans	follow with turnips
2'	Beans	follow with carrots
1 ½'	Carrots	follow with radishes
1' ½	Spinach	follow with turnips
1' ½	Parsley, Radish and Lettuce	
1'		

Scale $\frac{1}{4}'' = 1'$. Make rows as long as desired.

SIMPLE GARDEN PLAN

165. Discussion of the Plan.—It rarely pays to plant any crops closer together than 18 inches. This amount of space or even 2 feet is necessary not only to allow room for walking between the rows, but also to permit the use of all the common implements with the least amount of labor. This plan is given merely to illustrate what a garden plan looks like, and to assist in the making of one. The principles illustrated in this plan are those which should be shown in all garden plans.

166. Successive Plantings.—Wherever two or more rows of any one kind of vegetable are planted, either a space of time amounting to a week or two, should intervene between the plantings, or an early variety of the vegetable should be planted in one row, and a late variety, in the other. If the rows are long, one-half or

one-third of a row should be planted at intervals of about a week. This intervention of time between plantings is especially important with radishes and similar crops, if a continuous supply of the vegetable is desired.

There is no limit to the number of garden plans one may make for any particular area. All garden plans will vary according to the needs and tastes of the individuals who make them.

167. Further Suggestions.— Make the garden plan early so that the seed order may be made out and the seeds ordered and tested before the rush season starts. Buy seeds in bulk if more than one package is needed. Seeds purchased in packages are expensive. Carefully study a seed catalog and make selections from the best varieties, regardless of the price, always putting quality first. It will pay in the end. Order the seeds from reliable seed houses. Keep a record of the varieties planted. A good way to do this is to write the name of the variety on the garden plan, together with the dates of the plantings and the harvesting of the first crops. This will aid in the next year's work.

Keep garden accounts and a diary of your garden work.

Should you have a surplus of any crop, make an effort to sell it. Grocers are always ready to purchase fresh vegetables.

Raise your own seedlings, or young plants to be transplanted and you will then know what you are planting. Sell the extra seedlings you do not need. Every one should be able to sell good seedlings and any boy or girl who has studied agriculture should be able to grow,

at a very little cost, many good, strong, healthy seedlings.

168. Fertilizing the Garden.—Manure, compost, commercial fertilizers, and wood ashes are commonly used for fertilizing gardens. Well rotted manure is considered the best fertilizer, and from 20 to 30 tons per acre are often used. An application of 20 tons to an acre is equivalent to one ton to about 1000 square feet or to a piece of land 50 feet by 20 feet. The manure should preferably be applied in the fall before the garden is plowed, as this will give it time during the winter to partly decompose. Coarse, bulky, manure should not be used unless no other is available for gardening. A good application of a mixed fertilizer is 1000 lbs. per acre; this would be equivalent to about one pound to 43 square feet or to about 25 lbs. to a garden 50 feet by 20 feet.

Commercial fertilizers are applied differently; sometimes in the drill, sometimes by broad casting, and sometimes partly by broad casting and partly in the drill.

Wood ashes are worth saving and may well be applied to a garden in the same quantities or even in double the quantities that commercial fertilizers are. Unleached wood ashes vary in composition, but in general they contain about 1 per cent. phosphorus, 5 per cent. potassium, and 30 per cent. lime.

Lime is not generally regarded as a fertilizer, but is used to sweeten sour soils. Garden soils are likely to be sour, and an application of finely ground limestone, at the rate of about two tons per acre or 100 lbs. per 1000 sq. ft. every two or three years, will keep a garden in a sweet condition.

169. Preparation of the Seed Bed.—Spring plowed or spaded garden soils should be harrowed or raked until perfectly smooth and level. If the garden bed is prepared with horse implements, it will be necessary to go over the ground again with a rake, to break up all the lumps, and to rake out the stones and rubbish. Spring plowing, and in fact all spring work, should not be attempted until the soil is in a condition in which it will easily crumble. If the ground is plowed or worked when too wet, it will be impossible to make it into a good seed bed.

170. Staking Out the Garden.—Staking out the garden, and locating the rows, becomes a simple and easy operation when an accurate plan has been made. With a yard stick or tape, locate the end stakes, two for each row, placing them at the distances apart which are indicated on the plan. The entire garden should be thus staked out before any planting is done, as this will allow one to check up all the distances and to change some stakes if necessary. Laths cut into three or four parts and sharpened at one end make excellent stakes. These should be driven firmly into the soil and left, as they will greatly aid in all calculations of distance in planting the garden.

171. Planting the Seeds.—After the end stakes are all accurately located, the planting of the first row of early vegetables may be started. This is done by stretching a garden line attached to two good stiff stakes between the two end stakes of the row to be planted, and fastening the line to the stakes. With a rake the soil below the line should be smoothed and fined, and

then with a sharp stick, garden trowel, or one corner of the hoe, a small trench, as deep as is required by the kind of seed to be planted, should be made. The



MAKING DEEP DRILLS FOR THE LARGER SEEDS

From Circular 198, University of Illinois

garden line should now be moved out of the way and placed between the stakes of the next row to be planted.

In order to get a good stand, the seeds should be dropped into the trench somewhat more thickly than

the mature plants are desired to stand. After the seeds are sown the trench should be covered with the fine soil with the hand, rake, or hoe, and firmed either with the foot or by tamping upon the soil with a rake or hoe. To secure good germination it is necessary that the soil be pressed closely around the seeds.

172. Planting Succession Crops.—When one crop is harvested and a succession crop is to be planted in the same row, it is necessary to spade or deeply hoe that row and to get the soil again as smooth and fine as it was made in the first preparation of the seed bed. When this has been done, the garden line should be stretched once more between the stakes and the whole process of planting repeated just as it was at the time of the first planting.

173. Cultivation of the Garden.—Cultivation should not be started until the rows of vegetables can be seen. This should be within a week or ten days after the planting, if a few radish seeds have been planted with all the seeds which germinate slowly. Hoeing between the rows and leaving the soil rough and lumpy cannot be called good cultivation even though the process does kill the weeds. Cultivation must not only kill weeds but also conserve the soil moisture and in order to do this, the soil must be worked into a very fine condition. Hoeing and subsequent raking will accomplish this. Cultivation becomes an easy matter if a two-wheeled hand cultivator is used. Another excellent implement for cultivation is a three-tooth hand cultivator which has a handle about as long as a rake. This does the combined work of both

the hoe and the rake. If the seed bed is not compact, a good dust mulch may be established with a rake only, and if all the rows are far enough apart to insure easy use of the rake, the work may be done quickly.

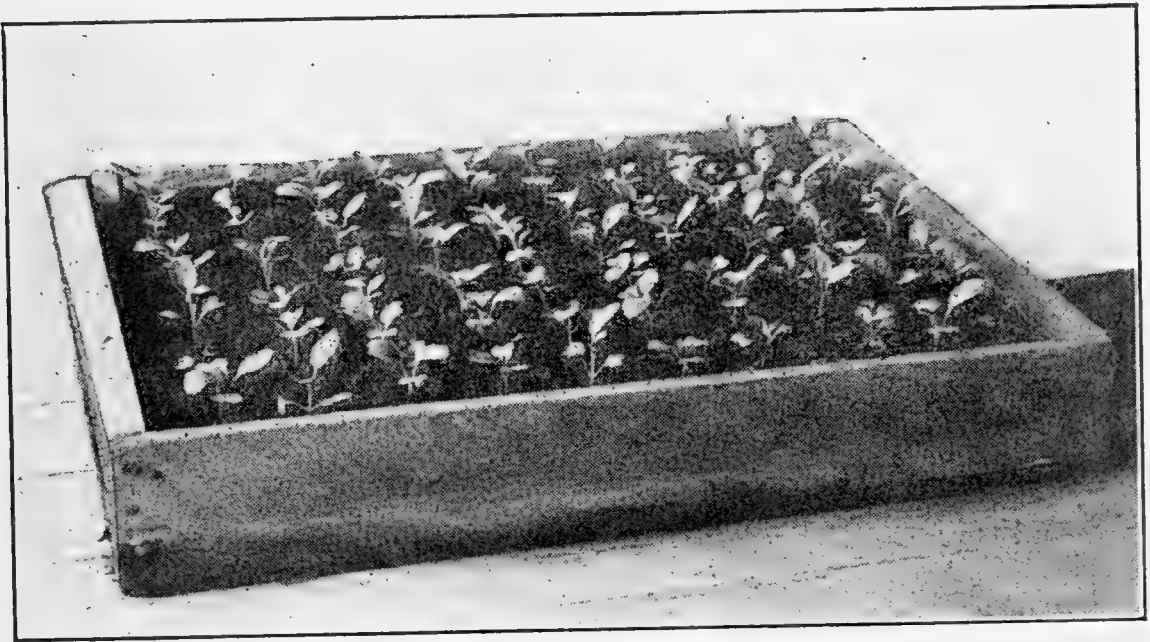
The garden should be cultivated as soon as expedient after every rain, and as often as weeds begin to appear. A dust mulch should always be maintained; and if this is done, no sprinkling or irrigation will be necessary unless there occurs a prolonged period of drought.

Cultivation need not be deep in a garden. One to two inches is generally considered deep enough. Hilling up corn, potatoes, and similar crops should be avoided, and all cultivation should be as level as possible.

174. Growing Seedlings to be Transplanted.—Young cabbage, tomato, celery, and other plants, which are usually transplanted into the garden, may be grown in green houses, hotbeds, cold-frames, and flats or shallow boxes $2\frac{1}{2}$ to $3\frac{1}{2}$ inches deep. It is more convenient to plant the seeds in flats than in the benches of the greenhouses or in the soil of the hotbed or cold-frames, but where they are so planted the rows should be three to six inches apart, the seeds but lightly covered. When the young plants are $1\frac{1}{2}$ to 2 inches high, they should be transplanted and given a little more room. Truck farmers usually plant the seeds thickly in flats and, after three or four weeks, transplant them to other flats where they have more room.

175. Transplanting Seedlings to Other Flats.—In the first flat, seeds may be sown very thickly, but when the young plants or seedlings are about an inch

and a half high, transplanting is essential. One small flat of such seedlings will furnish enough young plants to fill ten or twelve larger flats, with the seedlings placed in rows about one inch apart, and the plants one inch apart in the rows. This transplanting is a simple process. The larger flats are filled with the coarsely sifted soil. Depressions about one inch apart should be made in this soil, and, in the depressions, holes about



FLAT OF JERSEY WAKEFIELD CABBAGE PLANTS ONE WEEK AFTER SHIFTING.
— *Circular 198, University of Illinois*

one inch apart should be made with a small dibble. Into these holes the small plants should be set and the soil slightly firmed around them.

When the plants in these flats are 6 to 8 inches high the flats should be taken into the field, to transplant the plants into the places where they are to grow.

176. Transplanting Seedlings into Flower Pots. Quite often the seedlings are transplanted a second time before they are set in the field. When four to

six inches high, they may be transplanted into flower pots, tin cans, or dirt bands or paper pots. From these they may be transplanted later into the field with very little injury to the root system. This second transplanting, however, is more frequently done with young flowering plants than with vegetables.

177. Transplanting Seedlings to the Garden.—The young plants should be transplanted into the garden late in the afternoon on a cloudy day. Holes a little deeper and larger than necessary to contain the roots should be dug. Considerable water should be added to each hole and if desired, a little compost or rich soil may be put in the bottom of the hole after the water has been soaked up. In all transplanting it is desirable that the roots be disturbed as little as possible. The soil in the hotbed or flat, in which the young plants have been growing should be very moist when the plants are removed. The plants should be carefully removed and set a little deeper than they have been before; the earth should be firmed about the roots and watered before the holes are completely filled up. The process of filling up the holes is usually finished by working a little fine soil about the plants to act as a mulch. The tops should be reduced by cutting off about one-half to offset the loss from the root system caused by the transplanting. For a few days after transplanting the plants should be protected from the sun.

If the seedlings are in flower pots, in dirt bands, or in other individual retainers, it may be possible to transplant the seedling into the garden with the earth ball undisturbed about the roots. When this is done

the plants are not injured by transplanting and usually need no protection.

178. Thinning.—Thinning is an essential and important process. It is necessary because in order to secure a good stand, seeds are always sown a little more thickly than the plants are desired to stand. Lettuce, radishes, beets, and spinach, unless sown very thickly, may safely be left in the soil until they reach an edible size, and with these vegetables thinning becomes a frequently repeated process. All other garden vegetables should be thinned early, before the plants are injured by crowding. The weakest plants should be pulled out and only the strongest, if evenly distant from one another, should be allowed to stand. It is a good practice to work a little soil into the holes caused by pulling out the plants. This may be done with the foot, hoe, or rake. After the holes are filled, the soil should also be firmed, as the pulling often loosens considerable soil.

179. Fall Management.—About the middle of August some cover crop, rye or a mixture of rye and winter vetch, may profitably be sown in all parts of the garden where no crops are growing. About the first of September these cover crops may also be sown between the rows of all growing crops, as no further cultivation will be necessary. Where this sowing is done, the entire garden will be covered late in September with a thick green crop. This cover crop may be plowed in during October or early in the spring. Growing cover crops and plowing them in will both lighten the soil and maintain the supply of humus. The seeds of the

cover crops should be sown by broadcasting and covered at the last cultivation of the garden.

Late in the fall every garden should be thoroughly cleaned up; and all weeds, old vines and other refuse matter should be gathered up and burned, as these often harbor insects and plant diseases. If the garden is to be plowed in the fall, manure should first be evenly spread over it; if the garden has a cover crop growing upon it, much less manure is needed than when there is no cover crop to be plowed under.

QUESTIONS AND PROBLEMS

1. What kind of soil has your garden? What are the qualities of such soil?
2. Make a plan of your garden as it was planted last year, as well as you can remember. Indicate the scale.
3. Is the soil in your garden acid?
4. Have commercial fertilizers been used on your garden? Name them.
5. What small fruits are grown in your home garden?
6. What is the cost of a dozen of tomato seedlings? What would it cost to raise them?
7. If a ton of slaked lime is put on an acre of land how much should be put on a garden 50' x 50' at the same rate?
8. 1000 lbs. of a 5-8-10-fertilizer is considered a heavy application. How many pounds should be used for a garden 50' x 50' applying the fertilizer at the same rate?
9. For a 6" flower pot?

Farmers' Bulletins.

Home Vegetable Gardens, F. B. 255, 218.

Beautifying the Home Grounds, F. B. 185.

Home Fruit Garden, F. B. 154.

Production of Onion Sets, F. B. 434.

Canning Vegetables in the Home, F. B. 359, 521.

Vegetable Garden, F. B. 818.

The Small Vegetable Garden, F. B. 818.

The Farm Garden in the North, F. B. 937.

The City and Suburban Vegetable Garden, F. B. 936.

Home Gardening in the South, F. B. 934.

CHAPTER XVIII

PROPAGATION BY CUTTINGS AND BY OTHER MEANS

In propagating by seeds we produce new plants by putting into the ground parts of the parent plant, specially ordained by nature for this purpose, without injury to the parent. Another method of propagation is by cutting off a part of the parent plant and letting that grow separately. These removed parts are spoken of as *cuttings*, and the process is known as propagation by means of cuttings. In other cases a part of the plant may take root and grow into a new plant without being entirely separated from the parent plant. This is done by bending down a branch and covering it with soil; this process is called *layering*. In still other cases, plants may be propagated, or established plants entirely changed in many of their characteristics, by *grafting or budding*.

180. Growth from Buds.— In these other methods of propagating plants, the development of the new plant comes from buds instead of seeds. Every live stem or branch has buds along its sides and one, at least, at the end. When the leaves fall, the bud at the base of each leaf remains, and the next spring it opens into new leaves.

181. Cuttings.— To propagate a plant by cuttings, we remove a part of the stem that has at least one good

bud. This piece is put in water, moist sand, or some moist light soil. After its roots are well started, it may be carefully removed to the place where we want the plant to grow.

Soft-Wood Cuttings.—Many plants are propagated by cuttings. A few, as the begonia, may be propagated



STEM CUTTING OR SLIP OF COLEUS.—*United States Farmers' Bulletin 408*

from a leaf, rooting either in water or in damp sand. But plants are more frequently developed from thrifty shoots. This is the common method with geranium, coleus, heliotrope, ivy, salvia, and others. The shoots or cuttings are removed from the plants just above a node or joint so that they are about four inches long and contain two or more nodes. The part of the last internode is then removed from the cutting so that the cutting ends just below a node. The new roots form at the node and if the part below is not removed, it

will decay and may interfere with the formation of new roots. All the leaves on the lower nodes should be removed and those at the top should be trimmed to reduce the evaporating surface. When these things have been done the cuttings are buried in moist sand so that the remaining leaves and just a little of the top project above the surface. The cuttings should be kept warm by artificial heat when necessary.

After three or four weeks one of the cuttings should be carefully removed and if the roots are about an inch or so long, the cuttings may be transplanted into small pots containing a rich, light soil, and from there into larger ones as the roots fill the pots.

In the fall, practice making soft wood cuttings from some of the garden plants, and root, and pot these. This is a good way to acquire plants for the following spring.

Hard-Wood Cuttings.—Hard-wood cuttings, such as currant, gooseberry, grape, and all flowering shrubs, are generally made late in the fall after the leaves have fallen from the plants. Pieces of the one year old branches, containing two or three buds, are carefully cut from the plant. These are tied into small bunches and packed in green sawdust or moist sand in a cool cellar. They may be started in the house in February or March, or lie until the spring, and then be planted in a light rich soil. When they are planted they should be put deeply in the soil so that only one bud projects above the soil. They are generally put in the ground in a slanting position and the soil firmly pressed about them.

Practice making some hard-wood cuttings and keep them over the winter. In the spring plant them.

Potatoes and sugar cane are nearly always propagated from cuttings. A potato is a swollen underground stem and when it is cut into pieces to plant, we use a piece of the stem or a cutting.

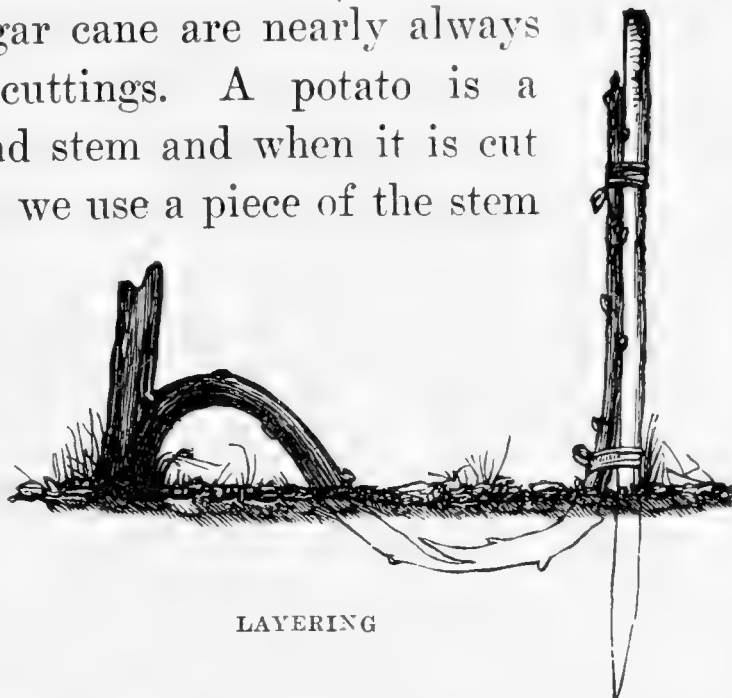
182. Layering.

In some plants buds may be made to root without being cut from the plant. A slender branch or stem is

bent down, then covered with soil. From the buds in this part of the stem, roots will grow. When they are well established the stem is cut off between the new roots and the old plant and we have a new plant.

Try the experiment of layering such bushes as gooseberry, raspberry, blackberry, and currant, and also grape vines.

183. Grafting.—Grafting consists in setting into a tree a little twig from another tree, so that it becomes a new branch. The tree on which the graft is made is called the *stock*, and the twig set into it, is a *scion*. More commonly, however, grafts are made differently. In case of the apple, roots from one year old apple seedlings are cut up into as many pieces as possible, each three to five inches long. These pieces form the stocks. Then tips of branches or scions, of the apple which is being propagated, are grafted to these



root pieces. These pieces of branches vary in length. Sometimes the entire branch is used, and at other times, depending upon the length of the scion, it is cut into three or more pieces. The branches used must be from wood only one year old. The digging of the seedlings, and the cutting of the branches, is done late in the fall. These are kept in moist sand in a cool cellar and some

time during the winter the grafting is done. This process of grafting to the roots is called *root grafting*.

The stocks and the scions should be of the same thickness, to get a good graft. Just under the outer bark is a thin, soft layer called the *cambium*. It is the living and active, growing part of a stem and root. Care must be taken to have the cambium layer of the scion come in contact with the same layer of the stock, otherwise no union between the two is possible. After the scion and graft are fitted together, they are kept in place by wrapping the piece of grafting tape or twine around the region of contact of the two. The grafts are then stored away in damp sand in a cool cellar, and in the spring, when the

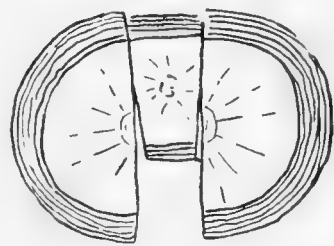


ROOT GRAFT.—The courtesy of the Iowa State Department of Public Instruction.

soil is in a good condition, they are planted.

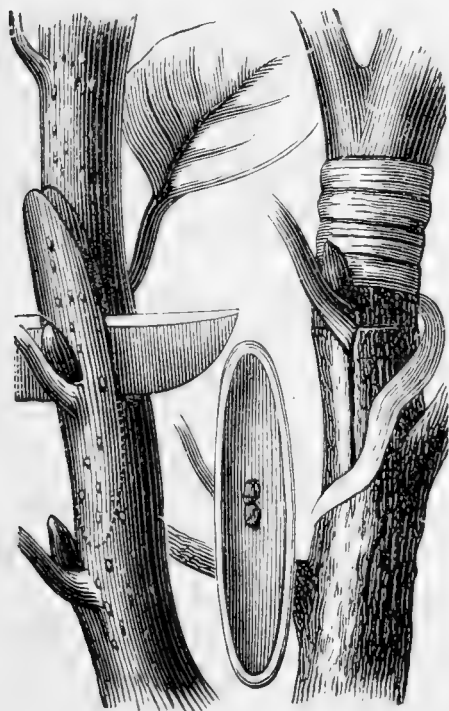
Practice root grafting by cutting slender willow twigs into pieces, six to eight inches long, and grafting these to any roots of the same thickness, merely for practice.

Cleft Grafting.—In cleft grafting the desired scions are removed late in the fall and stored during the winter in a cool, moist cellar. In the spring they are set into the stock where desired, as shown in the sketches. The freshly cut parts are then covered with grafting wax to keep out air and moisture. If the stock is large, often two scions are inserted into the stock at one point.



CROSS SECTION OF
STOCK AND SCION.—
United States Farmers' Bulletin 408.

184. The Necessity for Grafting.—Grafting is done to secure a better kind of fruit on a tree, to preserve and multiply a good variety, to replace lost branches, or to change the shape of a tree. All fruit trees in America are grown either from buds or grafts, as they do not come true to seed. The apple trees which nursery men sell are all grafted trees, developed from root grafts.



BUDDING

185. Budding.—The process of budding consists in inserting through the bark of a young tree a single bud cut from another tree. The desired bud is cut off with a sharp knife and is inserted in a T-shaped cleft made through the bark. The wound is then covered with grafting tape, strips of cloth

which have been saturated with melted wax.

Peaches, oranges and lemons are usually propagated

by budding. All that part of the trees developing from the inserted bud partakes of the nature of the tree from which the bud or scion was cut.

QUESTIONS AND PROBLEMS

1. Have you ever seen any one in your home propagate plants by cutting? If so, describe how they did it.
2. Why are cuttings generally rooted in sand rather than a rich soil?
3. What trees can be propagated by cuttings?
4. In grafting why must the cambium layers of the scion and the stock come in contact with one another?
5. How are carnations, roses, and begonias propagated?
6. Why is the spring a good time to do the grafting?

Farmers' Bulletins.

Propagation of Plants, F. B. 157.

Pruning, F. B. 181.

Bridge Grafting, F. B. 710.

CHAPTER XIX

THE ORCHARD

No orchard should ever be located in a low place where water is liable to accumulate. The best slope for an orchard is north or northeast, and the best soil is deep, gravelly loam or clay loam. Varieties of fruit best adapted to the locality and to the soil should be selected. If the orchard is well cared for, and its trees are properly sprayed and pruned, it will be very productive, and like the garden, will produce fruit which will surpass in value any of the common farm crops which could be grown on a similar area.

186. Management of Orchards.—Orchard soils are managed in many different ways; unfortunately many of the home orchards are not managed at all, but left entirely to themselves. The system of management generally regarded the best is called the “Tillage-cover-crop-System.” This system consists of cultivating the soil during the summer to maintain a dust mulch and to keep it free from weeds; then, some time in July or August, planting a fall crop or a winter crop, such as rye, winter vetch, or a mixture of both of these. This cover crop is permitted to stay on the land until spring when it is plowed under. The value of the cover crop is that it hastens the maturity of the fruit crop in the fall, checks erosion during the winter, and in the

spring adds much humus to the soil, which will make it light and retentive of much water.

The tillage given the soil in the spring and summer not only checks weed growth and conserves the moisture, but also causes the formation of available raw plant food which is necessary for a good crop and good growth of the tree.



PICKING AND PACKING APPLES

187. Fruit and Leaf Buds.—All our fruit trees and also our small fruits usually bear but two kinds of buds. These are the fruit or flower buds which produce the fruit; and the leaf buds which produce branches and leaves. Fruit buds if opened will show a little immature blossom, and the leaf buds will show small leaves and a little, immature stem. The parts in the

buds are all snugly nestled together and protected from the weather and enemies by the scales of the buds.

The fruit or flower buds are usually thicker and rounder than the leaf buds, which are more sharply pointed.

With a sharp knife cut lengthwise through a number of buds on some fruit tree and distinguish between the two kinds of buds. Note also the location of each.

Formation of Fruit Buds.— Practically all our fruit trees develop their fruit on one year old buds; that is, the fruit they bear is developed from buds which were formed in June of the previous year. When these buds are destroyed during the winter or in the early spring there will be no fruit the following summer. The two exceptions to this are the quince and the grape. These two plants develop their blossoms from the new wood formed in the spring from one year old branches. One cannot, therefore, find fruit buds on these plants during the winter.

Location of Fruit Buds.— The apple, pear, European plum, cherry, currant, and gooseberry, always bear their fruits buds at the ends of very short, lateral branches called spurs. When these spurs are destroyed, there will be no fruit until the plants form new fruiting spurs. If conditions are favorable, these short spurs produce fruit every year.

The peach, plum, apricot, and almond, bear their fruit buds at the ends of very short, lateral branches and not on spurs growing out from the sides. We sometimes say that the fruit buds are sessile, which means

without stalk. These branches bear fruit but one year; however, these one year old branches bear not only fruit buds but leaf buds which in their turn form new branches, and on these new branches the fruit buds of the next year are borne. In this way the plants continue to form fruit from year to year.

The raspberry and blackberry bear their fruit buds on the ends of one year old stems. When fruit buds have formed, the stems stop growing and after they have borne fruit, these stems die. If the ends of one year old stems are cut in the fall, these plants can not form any fruit the next year. New stems form each year, which develop fruit the following year, and then die.

188. Reasons for Pruning Fruit Trees.—Pruning is done to increase the vigor of the plant, to remove dead wood, to produce better fruit, to open the plant to light and air, to keep the plant within manageable shape and size, to facilitate in spraying, in gathering the fruit, and in cultivating, or to train the tree to some desired form. When young trees are set, it is usually best to prune away some of the branches, to allow for the loss of the roots destroyed in transplanting.

189. When and How to Prune.—Slight pruning may be done whenever a plant needs it. In the north, orchards are usually pruned late in the winter or early in the spring before the sap begins to move. Bleeding is bad for a plant, as it is difficult for the wound to heal, and it produces conditions favorable for infection. Grapes are usually pruned late in the fall. The old branches of blackberries and raspberries should be

cut out late in the summer to make more room for the new branches. If the new branches are cut back or headed-in when they are two or three feet high, they in their turn will develop more branches and thus the fruitfulness of the plant will be greatly increased.

Heavy top pruning, in all fruit trees, leads toward



WOUNDS MADE IN PRUNING

(Left) — Wound improperly made. Do not leave stubs. (Center) — The proper place to make the cut. (Right) — The properly made wound heals more rapidly.— *Wisconsin Bulletin 269*.

the formation of more woody growths, and thus lessens the formation of fruit buds. Top pruning, therefore, should always be done gradually a little each year.

The heads of fruit trees should be kept open so that air may circulate freely through the trees. Wherever the branches get so thick as to prevent this, some should be removed. Water sprouts, since they grow up into the center, should always be cut out.

Pruning during the growing season tends toward the formation of fruit buds, while pruning in the dormant season induces woody growths.

All pruning should be done with some definite object in view, and whenever cuts of large branches are made, they should be as close to the main branch as possible and parallel with it.



THE RIGHT WAY TO MAKE A SLOPING CUT JUST ABOVE A SOUND BUD. — *Courtesy of the Neosho Nurseries Co., Neosho, Mo.*

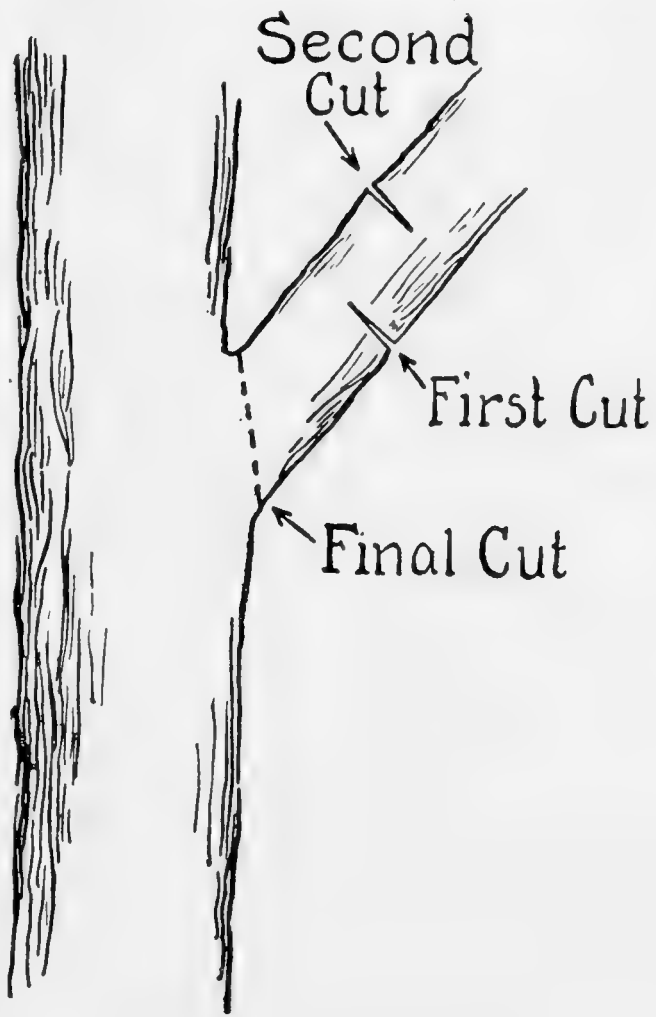
190. Dressing Wounds.— A few days after large branches have been cut from a tree, the cuts should be dressed with paint. For all purposes one or two coats of white lead will suffice; this closes the pores and keeps out all infection. Coal tar paints may also be used very effectively. The paint will be more effective the more smoothly the cuts are made.

191. Transplanting Fruit Trees.— In the colder regions, that is in the northern states, early spring planting of fruit trees is preferable. In the southern states fall planting is more successful.

When trees are planted in the fall in the northern states they are often winter killed. This is usually due to the fact that the trees do not have time to establish themselves before the growing season is over. This causes an excessive drying out in the plant, which kills it.

The hole should be dug twice as large as seems necessary and the bottom filled with fine rich soil. The roots of the tree should not be allowed to dry out during planting. All injured roots should be removed, and

the large one may be cut back slightly. The tree should be set a few inches deeper than it has formerly been growing. When the hole is dug and the roots are trimmed, the tree is ready to be planted. Set it in the hole with the large roots in the direction of the prevailing winds, or when on hilly land, up hill. Spread the roots out well and pack moist soil firmly about the roots, to be sure that all cavities around the roots are filled. The young tree should have the top pruned back, in the same proportion as the roots have been in the transplanting. Usually one third of the top should be cut off.



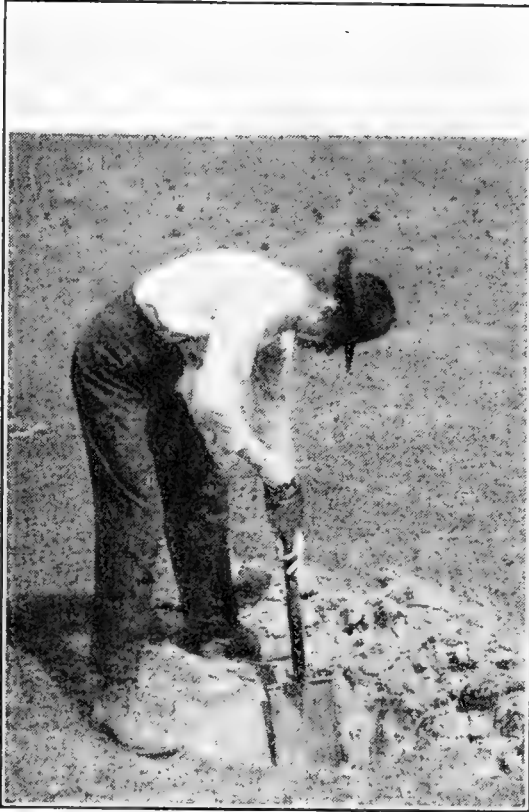
REMOVING LARGE BRANCHES

Splitting down often occurs in removing large branches. There will be little chance for trouble if the branches are cut away as indicated in this drawing.—*Wisconsin Bulletin 269.*

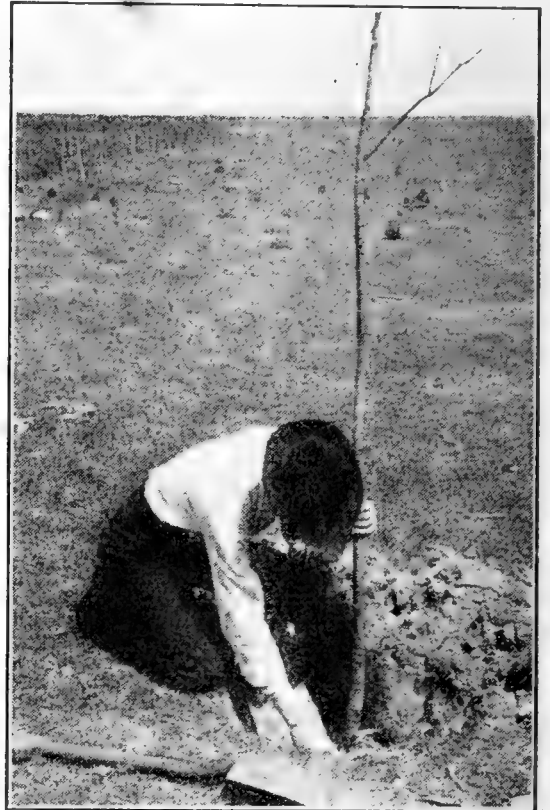
192. Apples.—An apple has nearly as much nutriment as a potato of the same weight. By a proper selection of varieties, a supply of apples may be had the year round. The apple tree is started from the seed, but as it will not come true to seed, at the end of the first or second season, a scion of the desired variety is grafted on the seedling

root. Apple trees should be planted from 30 to 35 feet apart.

Some of the most troublesome insects affecting the apple tree are the codling moth or apple worm, the curculio and scale insects. The two former can be controlled by spraying with arsenate of lead, just at the



1. DIG THE HOLE TWICE AS LARGE AS SEEMS NECESSARY AND FILL IN THE BOTTOM WITH FINE RICH SOIL.

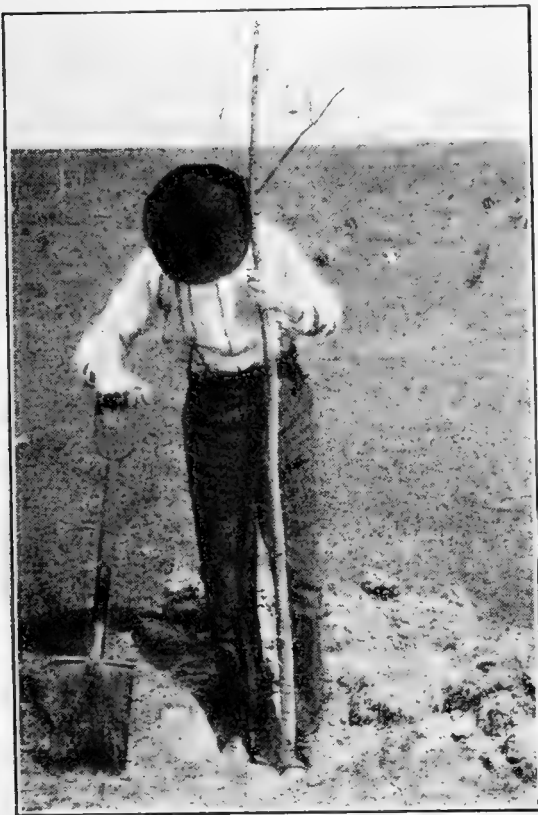


2. PACK THE SOIL FIRMLY ABOUT THE ROOTS, TAKING CARE TO SPREAD THEM.

time when the buds swell, two or three days after the petals of the blossoms fall, and then again two or three weeks later. Scale insects can be controlled by spraying with lime sulphur solution or kerosene emulsion, during the late fall, after the leaves have fallen, and early in the spring before the buds swell.

193. Pears.— Pear trees are usually planted more

closely together than apple trees; from 18 to 24 feet is the common distance between pear trees. Pear trees are subject to many ills; one of the chief of these is blight, a fungous disease which causes the ends of the twigs to turn black and die. It is controlled only by cutting out and burning the infected parts. The cut



3. AFTER THE ROOTS ARE CAREFULLY COVERED PRESS THE EARTH DOWN AS THE HOLE IS FILLED.



4. AFTER THE TREE IS PLANTED MULCH IT WITH LOOSE EARTH SO THAT THE MOISTURE MAY SOAK IN.

should be made about a foot below the lower part of the infected part of the branch. The codling moth, scale insects, scab and slugs, affect the pear tree. These should be treated as they are when they affect the apple trees. Slugs may be destroyed by spraying with kerosene emulsion.

194. Peaches.—Peach trees are usually planted 18 to 24 feet apart. The peach tree is attacked by many

pests and diseases. These pests are controlled just as described for apples; the Bordeaux mixture must be just half as strong as is usually used. Peach yellows and peach leaf curl are two fungous diseases, peculiar to peach trees. Yellows can be controlled only by cutting out and burning the infected parts. Leaf curl can be controlled by spraying with diluted Bordeaux mixture.

195. Cherries.—There are two common kinds of cherries, the sour, and the sweet. Sweet cherries are raised in California, Oregon, Washington, along the eastern shores of Lakes Michigan, Huron, Erie, and Ontario, and in sections of the south. They bloom earlier than do the sour cherries, and they are, therefore, only grown where there is little danger of early frosts.

The sour cherries bloom later, are hardier, and succeed fairly well in most parts of the United States. Cherry trees are commonly propagated by budding just as peach trees are. Cherry trees are planted from 20 to 25 feet apart. Cherries are attacked by scale insects, by curculio, by plant lice, by rot, and by leaf spot.

196. Plums.—Certain varieties of plums can be grown in most sections of the United States. They can be grown on a great variety of soils, and are usually regarded as very hardy and rugged plants. To secure good fertilization of the blossoms, it is advisable always to plant two or more varieties in the same orchard.

Plum trees are commonly planted 15 to 20 ft. apart. Plums are attacked by scale insects, by curculio, and by brown-rot. The last can be controlled by spraying

with a dilute Bordeaux mixture, half as strong as that used for spraying apples.

197. Grapes.—Grapes are raised with as little trouble as is any fruit, and they may be grown safely in all parts of the United States. Grape vines begin to bear in the third year, and sometimes a small crop may be gathered the second year. Grapes may safely be planted in the fall, even in the northern states, because the tops can be kept covered during the winter.

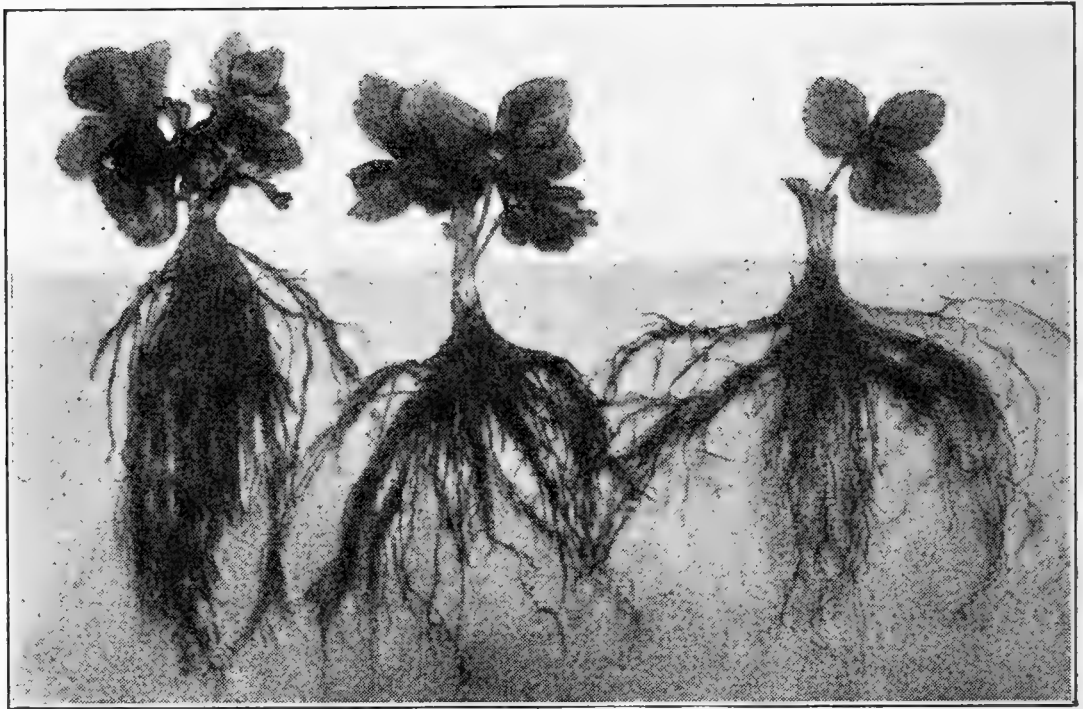
Grape vines are usually planted 8 to 10 feet apart, and are always trained to some support. The vines may be pruned any time during the late fall or early spring. Late spring pruning should be avoided, as the vines then bleed readily, and this bleeding, by making it difficult for the wounds to heal properly, is often a source of infection. It usually pays to spray grapes with Bordeaux mixture to control the fungous diseases.

198. Small Fruits.—Blackberries, raspberries, and dewberries, are usually planted in rows 5 to 6 feet apart, with the plants $2\frac{1}{2}$ to 3 feet apart in the rows. These fruits are commonly attacked by fungous diseases, which can be controlled by spraying with Bordeaux mixture.

Gooseberries and currants may be safely grown in all sections of the United States. The plants are commonly set in rows, 5 to 6 feet apart, with the plants 3 to 4 feet apart in the rows. They should be sprayed with Bordeaux mixture containing some poison. Later in the season, if pests are troublesome, the plants should be sprayed with white hellebore.

199. Strawberries.—The habit of growth of the

strawberry plant differs from that of all the other plants studied. When the strawberry plant has produced its fruit, it sends out runners which take root and produce new plants. These new plants are used to plant a new berry field. Only the strongest and best plants should be selected. The field into which the new plants are to set should be ready before the plants are dug or re-



Courtesy of the Neosho Nurseries Co., Neosho, Mo.

THE RIGHT AND WRONG WAY TO SET PLANTS

A
Too shallow

B
Too deep

C
Just right

ceived from the nurseryman. Strawberry plants are commonly planted in rows, three to four feet apart with the plants about 18 inches apart in the row.

Before the new plants are transplanted, the roots are generally trimmed back so that they will be about three inches long, and all the leaves, except two or three small ones, are removed. It usually pays to mulch straw-

berry plants in the fall with light, strawy, and coarse manure, or with other strawy material.

Some varieties of strawberry plants produce no pollen and are called imperfect plants. If only this kind is planted, naturally, no berries will ever form. Other varieties are perfect and produce pollen as well as pistils. It is therefore necessary when a variety of imperfect plants is planted, that perfect varieties also are planted with them in alternate rows.

The strawberry is the most important of all small fruits, and a small patch will usually supply more of the fruit than any family can use.

QUESTIONS AND PROBLEMS

1. Do the farmers in your community have orchards? How do they manage them?

2. Do they make it a regular practice to spray their orchards? For what and with what?

3. Examine some fruit trees in the early spring and try to distinguish between the fruit and leaf buds.

4. What are the advantages of low headed fruit trees?

5. What small fruits are most easily raised?

6. What small fruits bring the best price per quart?

7. Why might a rainy time when the trees are in blossom prevent a good crop of fruit?

8. At 12 cents each what will it cost for the plants to set an acre of blackberries?

9. At 25 cents each what will it cost for the apple trees to plant an acre?

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Fruit Growing in Great Plains, B. P. I. Cir. 51, 5 cents.

Fruits Recommended by American Pomological Society, 15 cents.

Cultivation and Fertilization of Peach Orchards, 1902 Year-book, Sept., 5 cents.

Farmers' Bulletins.

The Home Fruit Garden, F. B. 154.

The Apple, F. B. 113.

Grapes, F. B. 471.

Small Apple Orchard, F. B. 491.

Use of Fruit as Food, F. B. 293.

Home Mf'g. of Grape Juice, F. B., 175.

Grape Growing in the South, F. B., 118.

Home Vineyard in the North, F. B. 156.

Pears, F. B. 482.

Peaches, F. B. 632, 631, 633.

Strawberries, F. B. 198.

Blackberry Culture, F. B. 643.

Pruning, F. B. 181.

Growing Fruit for Home Use in The Great Plains Area, F. B., 727.

Dewberry Culture, F. B., 728.

Everbearing Strawberries, F. B. 901.

Raspberry Culture, F. B., 887.

Growing Peaches, F. B. 917.

CHAPTER XX

SPRAYING AND SPRAYING SOLUTIONS

200. Importance of Spraying.—The ravages of insect pests and plant diseases confront us everywhere. Fruit and shade trees, shrubs, and garden plants are continually being destroyed. Often the entire work of a season is wasted because of failure to insure a crop against the attacks of pests and diseases. It is almost impossible to grow a good crop of fruit without spraying the trees, and the use of insecticides and fungicides are indispensable on all well managed farms.

Every one engaged in the growing of fruits and vegetables ought to learn to know the common insect pests and diseases, and to be able to apply the right treatment to prevent their ravages.

Because of lack of practice in preparing spraying solutions and in using them many people consider the task of spraying too difficult to undertake. There is no better place than the school room in which to learn how to prepare all the common spraying mixtures, and how to apply them.

201. Classes of Spraying Solutions.—All our spraying solutions may be divided into two classes, *insecticides*, and *fungicides*. The suffix “cide” means to kill; therefore insecticides are substances which kill insects, and fungicides are substances which kill fungi.

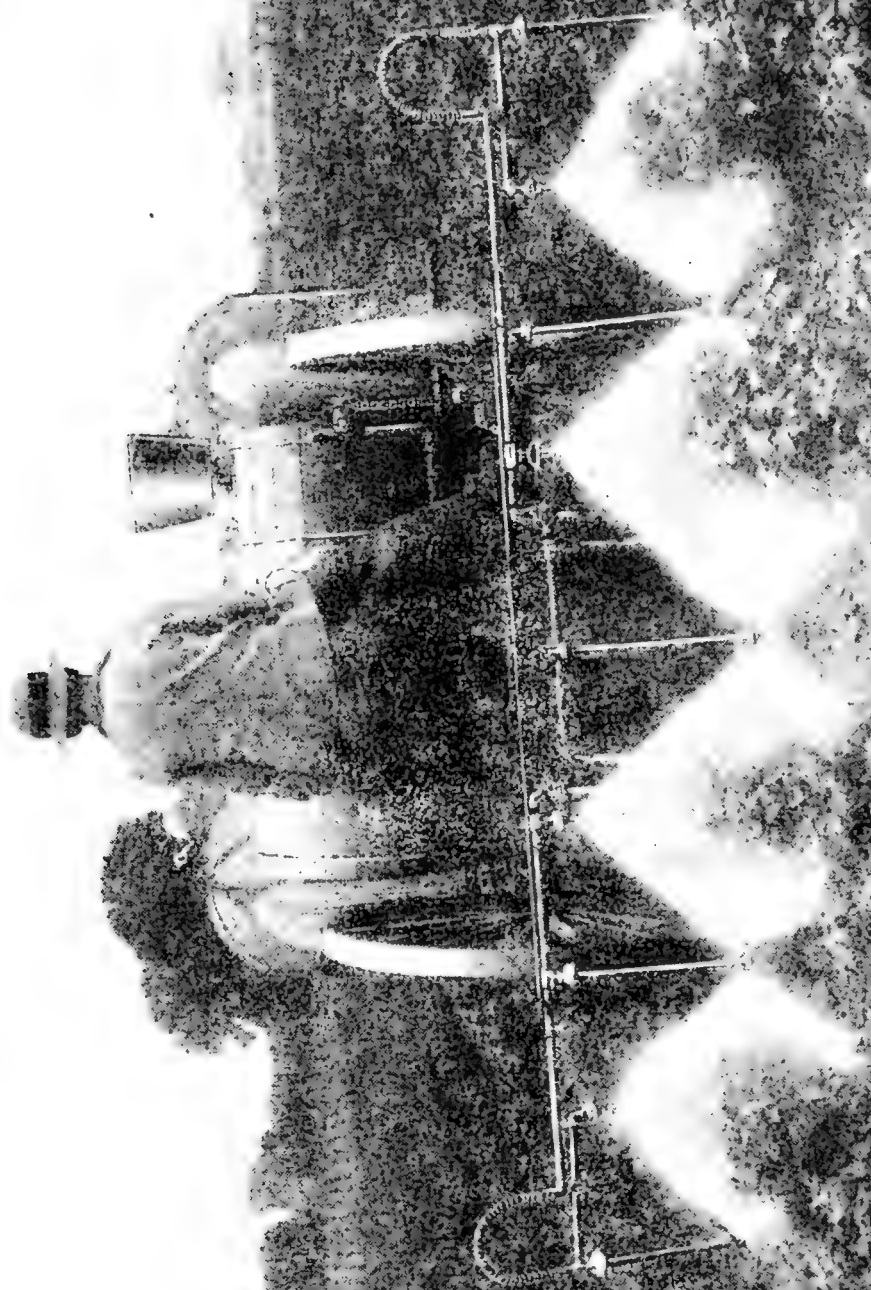
Insecticides are of two general kinds, the internal poisons, and the contact poisons. The latter kill the insect by coming into contact with his body and closing its breathing pores.



LITTLE SPRAYERS GIVE GOOD SERVICE

202. Fungicides.— The two common fungicides are Bordeaux mixture and lime-sulphur wash. For all common purposes the formula of common Bordeaux mixture is 4-4-50. For peach and plum trees a weaker solution is used, usually having a formula 2-2-50.

Common Bordeaux 4-4-50.— To make this solution, four pounds of sulphate are dissolved in 25 gallons of water, and four pounds of lime are slaked to make 25



TRACTION SPRAYER IN 4 ROWS OF POTATOES.—*The Bateman Manufacturing Company, Greenloch, N. J.*

gallons. The two are then mixed by pouring them into a third barrel. The mixed solution should not leave a trace of copper on a piece of bright iron wire. If it does, more lime should be added to the mixture.

Combined Bordeaux and Poison.—4-4-2-50.—Usually some poison such as arsenate of lead or Paris green is combined with the Bordeaux mixture.

Two pounds of lead arsenate in the form of a paste may be added to 50 gallons of Bordeaux mixture. This gives a formula 4-4-2-50. The advantage gained by this combination is that we can spray against both fungi and insects in one operation. If desired, in place of the arsenate of lead, from 4 to 8 ounces of Paris green may be used. Less of the Paris green than of the arsenate of lead is used because the Paris green has a tendency to injure foliage. In spraying peach trees, and other plants having tender foliage, Bordeaux mixture and lead arsenate, the 2-2-2-50 mixture should be used, and never should Paris green be combined with the Bordeaux mixture for these plants.

Use of Bordeaux Mixture.—Bordeaux mixture is the standard remedy for spraying against scab, certain blights, mildews, rots, leaf spots, leaf curls, and other fungous diseases.

Self-Boiled Lime-Sulphur.—Self-boiled lime-sulphur solution, having a formula 8-8-50, is often used as a summer spray against scab and other fungous diseases; however it is not as generally used as Bordeaux mixture.

Eight pounds of lime is slaked in a little water, and while the slaking is going on, eight pounds of sulphur

is added. The mixture is allowed to boil a few minutes, then enough water is added to make 50 gallons. Then after the mixture is strained, it is ready for use. To this mixture lead arsenate may be added if desired.

203. Insecticides.—The common poison insecticides for all cutting or biting insects are:—

- | | |
|---------------------|---------------|
| 1. Arsenate of lead | 3. Hellebore |
| 2. Paris green | 4. Pyrethrum. |

The common contact insecticides are:—

- | | |
|--------------------------|------------------|
| 1. Kerosene emulsion | 3. Miscible oils |
| 2. Lime-sulphur solution | 4. Scalecide |

204. Controlling Biting Insects.—In order to kill biting or cutting insects it is necessary to put a poison upon their food. A list of these poisons has been given. We will now briefly describe each.

Arsenate of Lead:—

2 to 3 lbs. arsenate of lead paste
50 gallons of water

or

1 to 1½ lbs. arsenate of lead powder
50 gallons of water.

Both the paste and the powder are sold on the market. A little water is added to the required amount of either the paste or the powder, to make first a thin paste, and then a thick solution. This solution is then added to the required amount of water. Arsenate of lead is more commonly used in combination with Bordeaux mixture, and the lime-sulphur when a summer spray is needed.

Paris Green: —

4 to 8 ounces pure Paris green

1-2 lbs. stone lime.

50 gallons of water

The formula given above is a common one for Paris green. On plants with tender foliage, such as the peach, not more than 4 ounces of Paris green are used with 50 gallons of water, lest injury to the leaves result. The lime is slaked separately and added to the

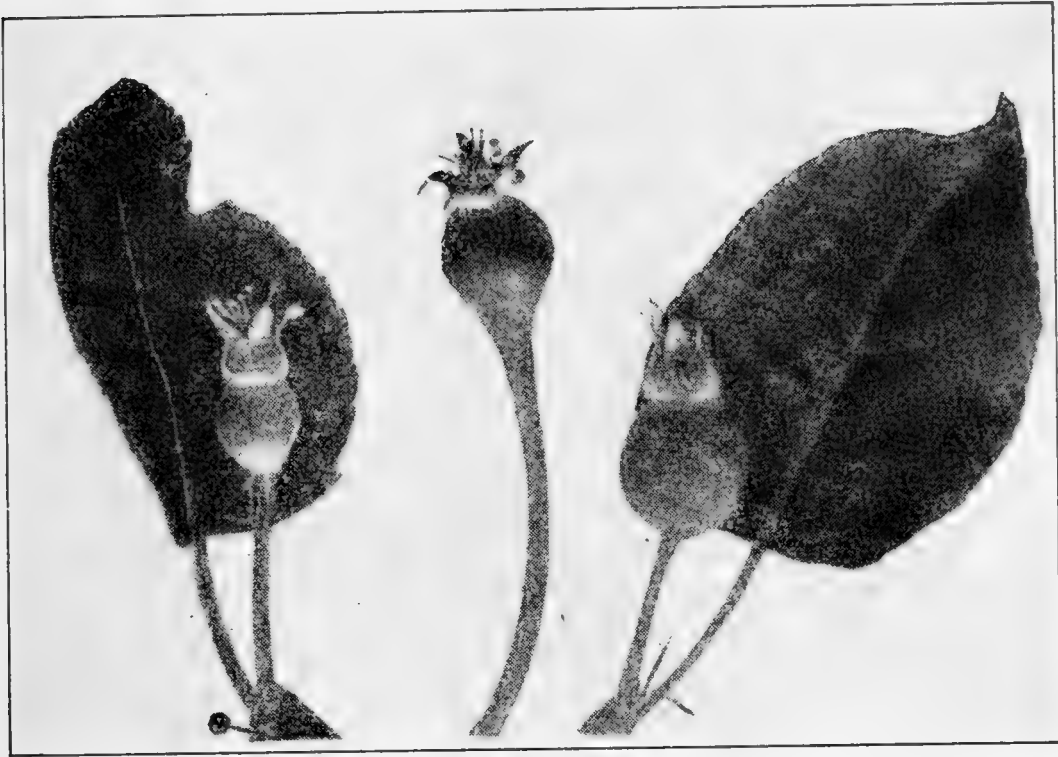


MAKING BORDEAUX MIXTURE

The two men pour together the diluted lime milk and the bluestone solution into a barrel or spray tank and stir well.— *United States Farmers' Bulletin 243.*

solution to prevent injury to the foliage. Paris green is cheaper than lead arsenate and therefore is still used extensively on potatoes. Paris green is sold on the market in a pure form, and very often, mixed with lime. One pound of the powder is often mixed with 20 pounds of flour, and this mixture is then used to dust plants. Used in this way, also, it is very efficient. Paris green and lead arsenate are the best insecticides

for all insects such as the codling moth or apple worm, potato beetles, cabbage worms, curculio, tent caterpillar, fall web worms, and other leaf eating insects.



TOO LATE TO SPRAY

Slingerland.— *Courtesy of the Iowa State Department of Public Instruction.*

205. Controlling Sucking Insects.— Sucking insects have beaks, or slender tubes, with which they pierce plant tissues and suck the juices from the plants. They must be killed by covering their bodies with a solution, or a powder, which, on coming into contact with them, closes their little breathing pores; they die of suffocation as a result. Common sucking insects are plant lice, scale insects, and squash bugs.

Kerosene Emulsion: —

Soap, $\frac{1}{2}$ pound.

Rain water, 1 gallon

Kerosene, 2 gallons.

To prepare kerosense emulsion the soap is cut into slices and dissolved in the soft water by boiling. The solution is then removed from the fire and the kerosene is added, either by means of vigorous stirring, or by pumping back and forth with the spray pump. This



YOUNG FRUITS READY TO SPRAY

Slingerland.— *Courtesy of the Iowa State Department of Public Instruction.*

process will form a creamy emulsion which may be kept indefinitely.

The emulsion mixes readily with water. When ready to use it, add 8 to 10 gallons of water to 1 gallon of the emulsion. This will make an efficient spray for all sucking insects.

Lime-Sulphur Solution.— There are two common kinds of lime-sulphur spraying solutions, and often

they are badly confused. One is more correctly called self-boiled lime sulphur. Its preparation we have described. In its preparation no artificial heat is used, as all required heat comes from the slaking of the lime; the mixture of lime and sulphur is only allowed to boil a few minutes. In this solution the sulphur does not dissolve to form soluble compounds but is held in suspension.

The term lime-sulphur solution, as commonly used, refers not to self-boiled lime-sulphur, but to a mixture made by boiling together, with artificial heat, lime and sulphur. When this boiling is done, the sulphur, together with the lime, forms a yellowish liquid which is called lime-sulphur solution. When this solution is made very strong, by using much sulphur and lime and little water, it is called concentrated lime-sulphur solution; in this form it may be purchased.

Lime-sulphur solution is one of the most efficient sprays for San José scale and for other scale insects. Used very dilutedly, it forms a good fungicide as already described.

One gallon of commercial lime-sulphur solution is often diluted with ten gallons of water as a dormant spray for scale insects.

Spraying for scale with lime-sulphur is most effective when the solution is applied to the trees in the spring shortly before the buds swell.

Scalecide.—Scalecide is a miscible oil, also used for San José scale and for other scale insects. It is a commercial product and one gallon of the oil is diluted with 10 to 14 gallons of water. It should be used when the

trees are not in leaf. It is very efficient, especially on badly infected trees, as the oil creeps readily beneath the scale of the insects.

As it is first necessary for a physician to make an examination of a patient to decide what ails him before administering medicines, so it is essential for one to know the common insects and plant diseases, and the effects of plant diseases, before determining what spray to use. Then, too, we know that certain insects, like the codling moth, are sure to make their appearance at certain times, and that certain plant diseases, like the potato blight, will invariably occur, if not prevented. This means that the proper preventives must be on the plants to safeguard them from the attacks of these enemies. These preventives protect plants just as vaccination or inoculation guard people against the attacks of certain diseases. Spraying should always be regarded as an investment rather than an expense. What does it cost to spray an acre of potatoes? If the yield of sprayed potatoes is fifty bushels per acre more than that of unsprayed potatoes, surely the cost of spraying pays good dividends.

QUESTIONS AND PROBLEMS

1. What spraying materials are used in your community?
2. What is the cost of spraying materials in your community?
3. How much more expensive is it to buy Bordeaux mixture in a powder and to make 50 gallons of a 5-5-50 solution than to buy the lime and the copper sulphate to make the solution?
4. How much copper sulphate and how much lime must be

used to fill a 14 quart pail with a 4-5-50 Bordeaux mixture?

5. What are the most troublesome plant diseases in your community that can be prevented? What spraying material should be used to control each?

6. What would it cost per bu. of potatoes to spray a potato field 3 times if the yield were 200 bushels per acre?

7. Why do Paris Green or other poisons on potato leaves not poison the potatoes' tubers in the ground?

8. What vegetables should not be sprayed with poisons?

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Codling Moth or Apple Worm, Yearbook, Sep., 460, 5 cents.

Principal Injurious Insects, Yearbook, Sep., 472, 5 cents.

Spraying Orchard Insects, Yearbook, Sep., 480, 5 cents.

Dust Preventives, Yearbook, Sep., 448, 5 cents.

Farmers' Bulletins.

Important Insecticides, F. B. 127.

San José Scale and Its Control, F. B. 650.

Fungicides, F. B. 243.

Cutworms and their Control, F. B. 739.

Control of Diseases and Pests of the Garden, F. B. 856.

Insecticides, Spraying Apparatus and Insect Pests, F. B.,
908.

CHAPTER XXI

FEEDING ANIMALS

All animals are kept for certain definite purposes, as the horse for labor, the cow for milk or beef, the hen for eggs. We give them food and care, in order that the results, or products, may be bounteous and good. It is a wasteful practice to keep farm animals out of doors in cold winter weather. It is useless to expect hens to lay eggs or cows to give milk, when they are suffering from cold, because this demands that a large proportion of the animal's food be used merely as fuel, to keep the animal warm. Animals that work hard require more food than idle animals. A cow that is producing a large quantity of milk needs more food than one that is producing little milk. He who can feed an animal with the most economical feeds for their greatest production is indeed a stock feeder.

206. Composition of Feeding Stuff.—The common constituents of feeds, or feeding stuffs, are *water*, *ash*, *protein*, *carbohydrates* and *fats*.

Water and Dry Matter.—All the grains and similar feeds contain from 8 to 12 per cent. water. The hays contain from 10 to 15 per cent water and succulent or juicy feeds, like corn silage and roots, contain from 75 to 90 per cent. water. The water contained in feeds has exactly the same use as that which the animals

drink. Since it would not be economy to pay a high price for a feed containing much water, analyses of feeds show the amounts of water they contain. If 100 lbs. of a feed contain 12% water, the analysis would show that the amount of dry matter in it is 88%. Dry matter, thus spoken of, means the weight of a substance



FARM-LIFE

The pleasant occupation of bringing in fodder in the winter time makes farm life worth while—especially if the corn stalks are frozen in the ground. The silo will put an end to this kind of work.—*Courtesy of the International Harvester Company.*

less the amount of water it contains. The following table is here inserted to show how the composition of feeds differs:

Ash.—The material which is left after straw or any feeding stuff has been burned, is called *ash*. It con-

POUNDS OF DRY MATTER AND DIGESTIBLE NUTRIENTS IN 100
POUNDS OF A FEW FEEDS

Feed	Dry Matter	Protein	Carbo- hydrates	Fats
Shelled corn	89.4	7.8	66.8	4.3
Oats	89.6	8.8	49.2	4.3
Cottonseed meal..	92.6	35.8	23.2	8.0
Linseed meal.....	90.2	30.2	32.0	6.9
Timothy Hay	86.8	2.8	42.4	1.3
Alfalfa hay	91.9	10.5	42.5	.9
•Corn silage	26.4	1.4	14.2	.7
Mangels	9.1	1.0	5.5	.2

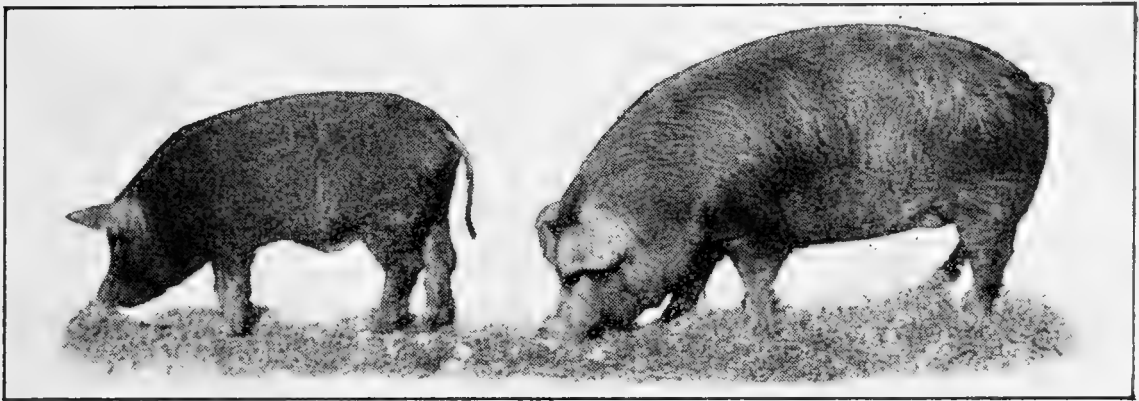


sists mainly of lime, phosphorus, and potassium compounds. The ash, or mineral substances of feeds, goes to form largely the bony structure of animals, and enters into the composition of some of the tissues and secretions of the body. As ash is present usually in abundance in all our common feeding stuffs, little attention is given to it. Corn, however, is rather low in ash, and when it is fed extensively to young pigs, their bones may not properly develop.

Well balanced rations made from a variety of feeding stuffs generally contain enough ash.

Protein.—Protein is the name given to all sub-

stances in feeds which contain the element nitrogen. They are therefore often called the nitrogenous nutrients. The amount of protein in the different classes of feeds varies greatly. Protein is the most expensive nutrient, and feeding stuffs, such as cottonseed meal, containing much protein are always the most expensive. Protein forms the flesh of animals. It is also found abundantly in skin, blood, wool, hair, and



PIGS OF THE SAME AGE

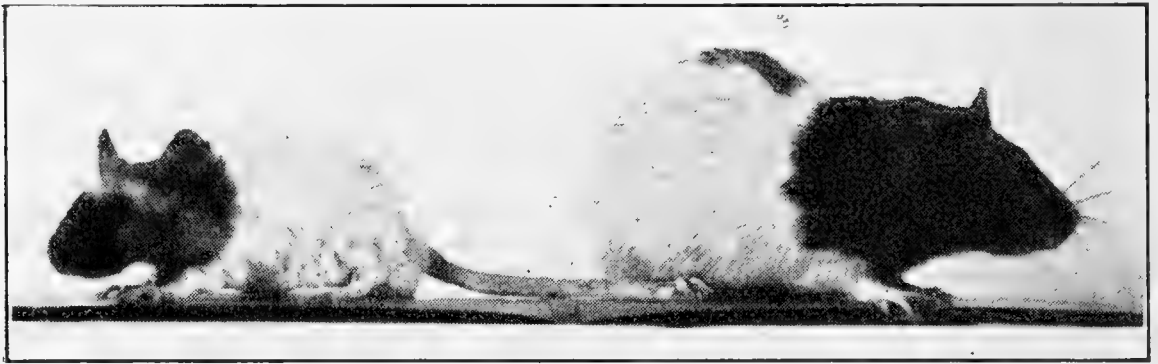
Pig on the left was fed wheat and wheat gluten; weight, 55 lbs. Pig on the right was fed wheat and milk; weight, 165 lbs.—*Courtesy of Hoard's Dairyman, Fort Atkinson, Wis.*

horn of animals. Milk and eggs are rich in protein. Much protein is required by all growing animals, and by animals which give us a product such as eggs and milk, which is rich in protein.

Efficiency of Protein.—Recent experiments with animals show that proteins differ in nutritive value. The proteins from the grains, and from their by-products are not as efficient in producing growth in young animals as are those proteins obtained from milk and from other animal products. Pigs and other animals, fed entirely on grains and other vegetable

feeds, have, in experiments, made much less growth than pigs that have received a considerable quantity of their protein from skimmed milk or other animal products. These results show the great value of dairy by-products in raising young stock.

It is also known that chickens will lay better if, in addition to their common feed, they are fed some animal product such as skimmed milk, buttermilk, or meat scraps. Skimmed milk and tankage are valuable also for fattening growing swine; when these feeds are



RESULT OF POOR AND GOOD PROTEIN

The protein content was the same in the ration of both of these rats, but in one case (left) it was poor protein, and in the other good protein. There is much difference in the value of protein from different sources.—*Courtesy of Hoard's Dairyman.*

used, in connection with vegetable feeds, quicker and cheaper gains are made.

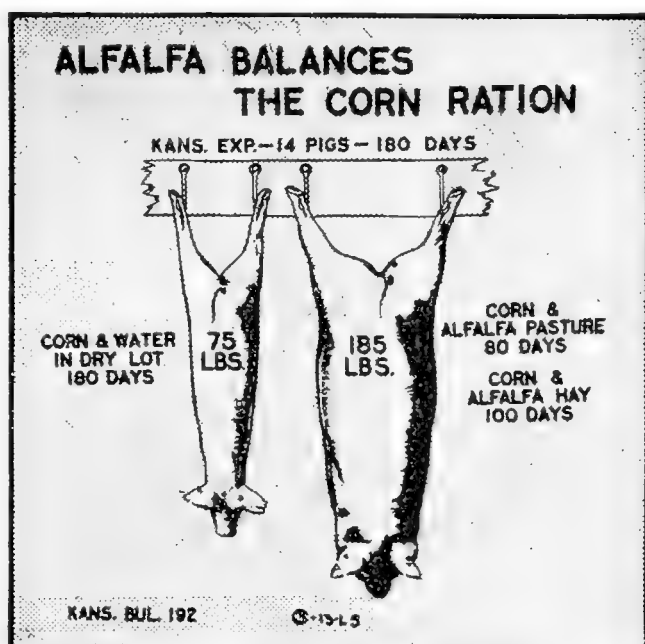
Carbohydrates.—The carbohydrates are substances such as starch, sugar, and cellulose. By far the greater part of all our plants are carbohydrates. The cellulose, which forms the cells and tissues of plants is not very digestible and is often spoken of as fiber. Straw, hay, hulls of seeds and similar substances contain much fiber which tends to make them less valuable than other feeds.

The carbohydrates are primarily energy forming

nutrients and are burned in the system to produce energy and heat.

Fat.— The amount of fat in feeds varies greatly. Flaxseed contains 29% fat, peanuts 35.6% shelled corn 4.3%, and beets .1%. The nutritive value of fat is $2\frac{1}{4}$ times as great as is a similar amount of carbohydrates and protein, for the production of energy and heat. Therefore, when in computing rations for animals, one wishes to reduce the amount of fat to carbohydrate equivalent, one multiplies the amount of fat by 2.25. The fat in feeding stuffs is either stored up in the body as fat, or is burned to furnish heat and energy.

207. Feeding Stuff Laws.— Most states now have a law regulating the sale of feeds. These laws generally require that the amounts of nutrients and fiber, contained in concentrate feeding stuffs, be stamped upon the sacks or upon tags fastened to the sacks. These laws aim to prevent adulteration of feeding stuffs. It should be the business of every farmer and of every student of agriculture to know and to be able to interpret exactly the meaning of the terms used in these analyses.



ALFALFA

Courtesy of the International Harvester Company

The Wisconsin Feed Inspection Department recently received two samples of feed for analysis that had been offered to farmers for \$23.50 per ton. It looked good and smelled good, but on examination it was found to consist principally of peanut hulls with about 8 per cent oil, and contained 56 per cent fiber. Such feeds contain fewer pounds of digestible nutrients than wheat straw, yet mighty few farmers would pay \$23.50 per ton for wheat straw in carload lots. Such are the ways of the feed adulterator and thus are unreading farmers victimized.

208. Digestible Nutrients in Feeding Stuffs.—

The value of any feed depends upon the amount of digestible nutrients it contains. Those not digestible are of no use to the animal. In buying feeds, we must not be misled by statements showing their compositions, because a large portion of the nutrients are not digestible. The amount of digestible nutrients in feeds is only what one should consider.

209. **Classes of Feeding Stuffs.**—All feed may be divided into two classes, called concentrates and roughages. Concentrates include all the grains, such as corn, oats, wheat, etc., and their milling by-products, such as bran, middlings, flour, etc. . . *Concentrates* are condensed feeds containing large per cents of digestible nutrients and small per cents of indigestible fiber. *Roughages* are coarse and bulky feeds such as hay, silage, straw, roots, etc. . . They contain less digestible nutrients and more fiber than do the concentrates.

210. **A Ration.**—A ration is all the feed given to an animal in one day, whether fed to it once, twice, or three times a day, or oftener. It is often necessary to calculate the weight of a ration. This is done by weigh-

ing the feed given an animal at each meal during the day, and from these figures, determining the total weight of the feed for the day, or the weight of the ration. Knowing this weight it is a simple matter to determine the cost of a ration. If a dairy cow is fed in one day

12 lbs. of clover hay	4 lbs. of ground oats
30 " " corn silage	2 " " corn
1 lb. of wheat bran	

what would be the cost of the ration if the hay is worth \$10.00 per ton, the corn silage \$3.50 per ton, the ground oats and the ground corn each \$1.50 per 100 pounds, and the wheat bran \$28.00 per ton?

$$\begin{array}{rcl}
 \frac{12}{2000} \text{ of } \$10.00 & = & \$0.06 \\
 \frac{30}{2000} \text{ of } 3.50 & = & .0525 \\
 \frac{4}{100} \text{ of } 1.50 & = & .06 \\
 \frac{2}{100} \text{ of } 1.50 & = & .03 \\
 \frac{1}{2000} \text{ of } 28.00 & = & .014 \\
 & & \hline
 & & \$0.2165
 \end{array}$$

The cost of the ration is nearly twenty-two cents.

Find out what the rations being fed to different farm animals are. Then learn the market or farm value of the feeds being fed; and determine the cost of some of the rations.

From this find out the cost of feed for a week and for a month for certain farm animals.

211. Nutritive Ratio of Feeding Stuff.—The nutritive ratio shows how many parts of combined carbohydrates and fats there are in a feed in proportion to one part of protein. Since the nutritive value of the fat is $2\frac{1}{4}$ times that of the carbohydrates and the protein, in finding the nutritive ration, the amount of digestible fat must first be multiplied by 2.25. This result is then added to the amount of digestible carbohydrates to get the combined weight of the nutrients which contain no protein. This combined weight compared with the weight of the protein, gives the nutritive ratio. This ratio or comparison is generally written thus: 1:7, 1:12, etc., indicating that there is by weight one part digestible protein to seven or to twelve parts of digestible carbohydrates and fat combined. The formula for determining the nutritive ratio is:

$$\frac{\text{Dig. carbohydrates} + (\text{dig. fat} \times 2.25)}{\text{digestible protein}} = X$$

then 1 : x equals the nutritive ratio.

One hundred pounds of corn contain 7.8 lbs. digestible protein, 66.8 lbs. digestible carbohydrates, 4.3 lbs. digestible fat.

Its nutritive ratio is 1:9.8. The calculations for determining this nutritive ratio are given below.

$$\frac{66.8 + (4.3 \times 2.25)}{7.8} = \frac{75.475}{7.8} = 9.8$$

Therefore the nutritive ratio of corn equals 1:9.8.

Determining the Nutritive Ratio of Rations.—In order to get the nutritive ratio of a ration, we must

first consult a table showing the average amount of digestible nutrients in feeds. (See Table 4 in the Appendix.) Since in the table the composition of 100 lbs. of each of the nutrients is given, we must find out how much of each of these nutrients there is in the amounts given in the ration. Below is calculated the nutritive ratio of a ration. The work also shows the amount of dry matter in the ration and the total amount of all the digestible nutrients. To get the total amount of all the digestible nutrients, the total amount of fat in the ration is multiplied by 2.25 and the result is added to the total amount of protein and carbohydrates.

Feeding Stuff	Dry Matter	Protein	Carbo- hydrates	Fat	Total Digestible Nutrients
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
10 Alfalfa hay ..	9.19	1.05	4.05	.09	5.30
30 Corn silage ...	7.92	.42	4.26	.21	5.15
3 Corn and cob meal	2,547	.132	1.80	.087	2.13
2 Ground oats...	1.76	.202	1.05	.074	1.42
1 Wheat bran...	.881	.119	.42	.025	.60
Total	22.298	1.923	11.58	.486	14.60

$$\frac{11.58 + (.486 \times 2.25)}{1.923} = \frac{12.6735}{1.923} = 6.6$$

Therefore the nutritive ratio equals 1:6.6.

Using the form of a table similar to the one above, find the nutritive ratio of some rations being fed to farm animals.

Narrow and Wide Nutritive Ratios.—The nutritive ratio of timothy hay is 1:16.2. That is, timothy hay has 16.2 times as much digestible carbohydrates and fats as it has protein. It is said to have a wide nutritive ratio. Cottonseed meal has a nutritive ratio of 1:1.1. That is, it has almost as much digestible protein as it has digestible carbohydrates and fats. Therefore,

it is an example of a feed having a narrow nutritive ratio. The nutritive ratio of oats is 1:6.7. This is a medium nutritive ratio.

212. Balanced Rations.—A balanced ration is one which furnishes an animal the *proper amount* of each of the three digestible nutrients, protein, carbohydrates and fat, *in the proper proportions*, without excess of any nutrient. The proportion of the different nutrients is found by determining the nutritive ratio of the ration; and the amount of the nutrients is obtained by determining the total amount of all the digestible nutrients in the ration as described above.

213. Feeding Standards.—Many very careful feeding experiments have been conducted in all parts of the United States by the different agricultural colleges. From these experiments agricultural experts have found out what kinds of feeds, what amount of nutrients, and what nutritive ratios, give the best results. These results are published in agricultural bulletins and serve as general guides in feeding animals. These results are commonly termed *feeding standards* and an intelligent use of these standards will prove immensely to the advantage of every one who owns stock.

Table 5 in the Appendix shows a feeding standard for dairy cows, used extensively in the Middle West. The following paragraph explains how the standard is used.

Let us use, for example, the Haecker standards for feeding dairy cattle, and calculate the nutritive requirements for a cow weighing 1200 lbs. and producing 30

lbs. of 3.6% milk per day. Let us also find out the nutritive ratio and the total amount of digestible nutrients required.

DIGESTIBLE NUTRIENTS REQUIRED FOR A 1200 LB. COW PRODUCING 30 LBS. 3.6% MILK PER DAY

Use	Digestible		
	Protein	Carbo-hydrates	Fat
For maintenance (1200 lbs.)	.84	8.40	.12
For production (30 lbs. of 3.6% milk)	1.50	6.60	.57
	—	—	—
Nutrients required	2.34	15.00	.69

$$\frac{15 + (.69 \times 2.25)}{2.34} = \frac{16.5525}{2.34} = 7.07$$

Therefore the nutritive ratio = 1:7

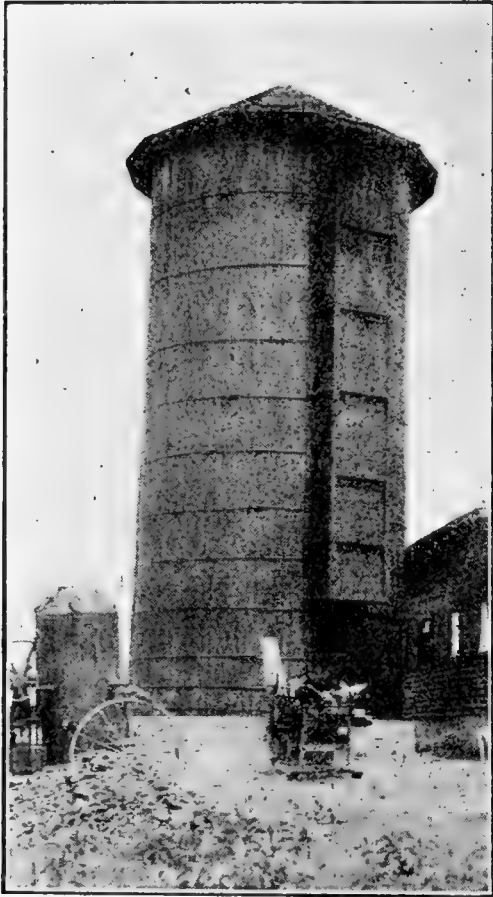
The total digestible nutrients = 18.89

$$16.5525 + 2.34 = 18.8925$$

Calculations for the nutrient requirements for all dairy cattle may be made in the way illustrated above and the feeding standards given in the Appendix of this book may be used. There are other feeding standards which are used in the same way. Table 6, Appendix, is one adapted for all kinds of live stock.

Find out the approximate weight of some dairy cows, and the amounts of milk they are producing, and the tests of the milk. From these data calculate the nutrients required, and the nutritive ratio of these nutrients, according to the Haecker standard given in the appendix. Table 5.

214. Balancing Rations.— If an animal requires in a day ten pounds of digestible nutrients, having a nutritive ratio of 1:7, the ration will be balanced if that



A GOOD SILO

animal is given a ration of suitable, palatable, and varied feeding stuffs containing ten pounds of digestible nutrients which have a nutritive ratio of approximately 1:7.

In order to balance a ration for an animal, we must, therefore, first know what the requirements for that particular animal are; that is, we must know what to balance.

As has been illustrated, our feeding standards are the guides which show us what the average animal requires in order to give the best results without any waste.

To illustrate balancing a ration by an example, let us assume that we want to feed, according to the Haecker feeding standards, a balanced ration to a dairy cow weighing 1000 lbs. and producing 20 lbs. of 4% milk, per day.

According to the Haecker feeding standard, the following nutrients will be required, and the nutritive ratio of these, as given below is 1:6.9.

NUTRIENTS REQUIRED

Use	Protein	Carbo- hydrates	Fat
	lbs.	lbs.	lbs.
For maintenance 1000 lb. cow .....	.70	7.00	.10
For 20 lbs. 4% milk.....	1.18	4.80	.42
	<hr/>	<hr/>	<hr/>
Nutrients required	1.88	11.80	.52

$$\frac{11.8 + (.52 \times 2.25)}{1.88} = \frac{12.97}{1.88} = 6.9$$

Therefore the nutritive ratio is 1:6.9.

The total amount of digestible nutrients = 1.88 + 12.97 or 14.88 lbs.

Now, let us assume that we have the following feeding stuffs to feed the animal, and let us figure out a trial ration.

NUTRIENTS PROVIDED

Amount	Feed, Kind	Dry Matter	Digestible		
			Protein	Carbo- hydrates	Fats
lbs.		lbs.	lbs.	lbs.	lbs.
10	Alfalfa hay...	9.19	1.05	4.05	.09
30	Corn silage...	7.92	.42	4.26	.21
3	Corn and cob meal	2.54	.132	1.80	.087
2	Ground oats..	1.76	.202	1.05	.074
2	Wheat bran ..	1.76	.238	.84	.05
		<hr/>	<hr/>	<hr/>	<hr/>
	Nutrients pro- vided	23.17	2.042	12.00	.511
		<hr/>	<hr/>	<hr/>	<hr/>
	Nutrients re- quired .....	...	1.88	11.80	.52

The nutrients provided in the trial ration are but slightly different from those required. There is, how-

ever, an excess of protein and of carbohydrates. By reducing the amount of wheat bran, and increasing the amount of corn silage, we can balance the ration a little better, as the work below shows.

NUTRIENTS PROVIDED

Amount	Feed, Kind	Dry Matter	Digestible		
			Protein	Carbo-hydrates	Fats
lbs.		lbs.	lbs.	lbs.	lbs.
10	Alfalfa hay..	9.19	1.05	4.05	.09
33	Corn silage..	8.71	.462	4.686	.231
3	Corn and cob meal	2.54	.132	1.80	.087
2	Ground oats.	1.76	.202	1.05	.074
1/2	Wheat bran.	.44	.059	.21	.012
		—	—	—	—
	Nutrients provided	22.64	1.905	11.796	.494
		—	—	—	—
	Nutrients required .....	....	1.88	11.80	.52

$$\frac{11.796 + (.494 \times 2.25)}{1.905} = \frac{12.9075}{1.905} = 6.77$$

Here the nutritive ratio of feed provided equals 1:6.77. The total amount of digestible nutrients is 14.81.

$$1.905 + 12.9075 = 14.81$$

Nutritive ratio in requirements = 1:6.9.

“ “ “ feed provided = 1:6.77

Total digestible nutrients required = 14.85

“ “ “ in feed provided = 14.81 lbs.

Although these do not exactly balance, they are so near, that we may safely say the ration is balanced.

If a cow is fed in a day about one pound of hay and three pounds of silage for each one hundred pounds of

live weight, and one pound of a good mixture of concentrates for each three or four pounds of milk produced in a day, she will be fed a fairly good ration. These directions aid in balancing a ration.

Balancing rations often requires considerable work, but there is nothing difficult about the work if the process is clearly understood. If time permits, balance rations for dairy cows, putting the final results in tabular outlines such as were used above.

The feeding of farm animals is a very important subject for farmers and project workers. One can get good advice on this subject from his county agricultural agent if there is one in his county. Another important source of information is the State Agricultural College of his state. Here experts are constantly working on the problem of better and cheaper rations, and these men are in touch with local conditions. Every one interested in this subject should write to his State Agricultural College for a list of available bulletins. Another important source of information is Henry and Morrison's "Feeds and Feeding." This book is considered the standard work on feeding every class of live stock.

QUESTIONS AND PROBLEMS

1. Give a list of feeds that are adapted to growing animals.
2. Give a list of feeds adapted to animals doing hard work; to those producing a product rich in protein.
3. Determine the ration being fed to some home animal. Determine the cost of the ration, using local prices.
4. Multiply the food ration in problem 3 by 365 and determine the amount of the different feeds required for a year.

5. Determine the cost of the year's feed found in problem 4 using current local prices.

6. Determine the amount of total digestible nutrients in a bushel of oats and in a bushel of corn, and the value of one pound in each.

7. If the bushel of oats sells for 50 cents and the bushel of corn for 75 cents, what is the cost of one pound of digestible nutrients in each?

8. Calculate the nutritive ratios of the ration found in problem 3.

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Feeding for Beef Production, A. I. Bul. 108, 10 cents.

Maintenance Rations for Farm Animals, A. I. Bul. 143, 15 cents.

Influence of Type and Age in Feeding Cattle, A. I. Bul. 128, 30 cents.

Economic Feeding of Beef Cows, Dept. Bul. 615, 5 cents.

Farmers' Bulletins.

Feeding Farm Animals, F. B. 22.

Making and Feeding Silage, F. B. 578.

Nutritive Value of Food, F. B. 142.

Feeding Dairy Cows, F. B. 743.

Computing Rations by Use of Energy Values, F. B. 346.

The Feeding of Dairy Cows, F. B. 743.

Feeding and Management of Dairy Calves, F. B. 777.

Utilizing Farm Wastes in Feeding Live Stock, F. B. 873.

Homemade Silos, F. B. 855.

The Self-Feeder for Swine, F. B. 906.

CHAPTER XXII

POULTRY

215. Importance of the Poultry Industry.—Practically every farmer in the United States owns some poultry; and there is no class of live stock so widely distributed. Because on the average farm, the amount of money invested in poultry is so little, we often do not realize what a large industry the poultry business is in the United States. The sale of eggs and table fowl is about \$300,000,000 per year.

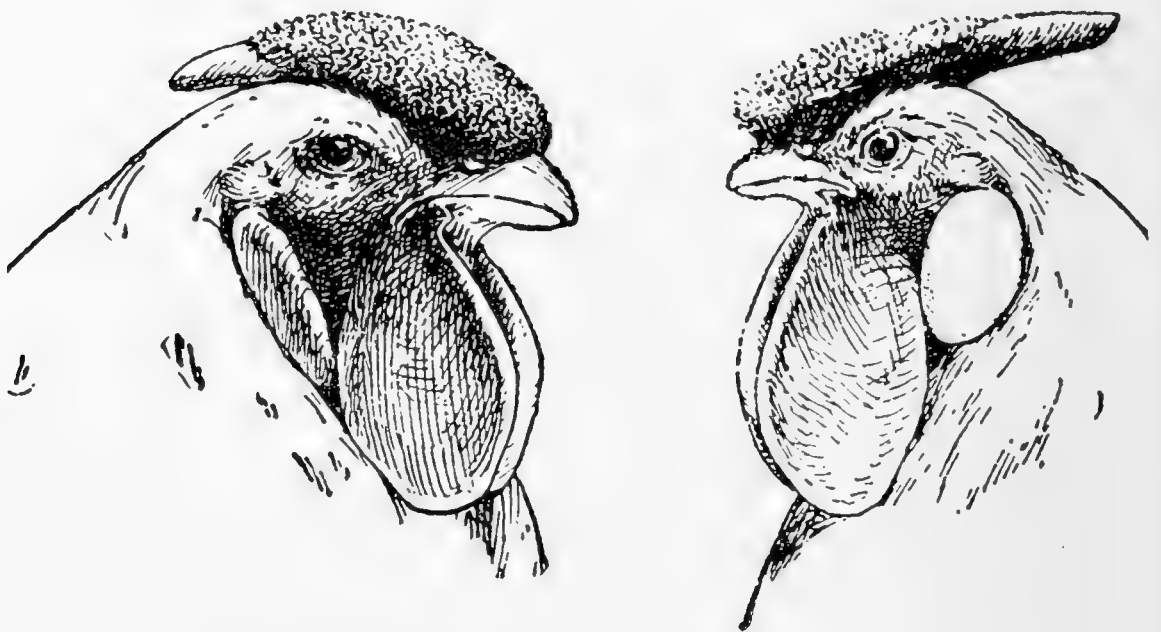
216. Benefits of Poultry Raising.—Every year



SINGLE COMB FOUND ON MALES OF SOME VARIETIES
University of Missouri College of Agriculture Circular 8.

many more farmers are realizing that it pays to keep more poultry on their farms. Poultry raising requires little work. It makes a pleasant activity for the young people. The investment in poultry is usually small;

little land is required, most of the feed is raised on the farm; many waste products are utilized; and, during a considerable part of the year, the flock lives largely on the litter about the barn and the feeding pens; and on the gleanings from the grain fields. Besides, large numbers of insects are eaten by the poultry as they range over the farm. Poultry products as eggs, broilers, and adult fowls of various kinds, are all easily



COMB OF THE WYANDOTTE AND ROSE COMB LEGHORN

The rose comb has different characteristics, depending upon the breed.—*University of Missouri, College of Agriculture, Circular 8.*

marketed, and the certainty of the market is another good feature of the business.

217. Classes and Breeds of Chickens.—The four most common classes of chickens are the Mediterranean, the Asiatic, the American, and the English.

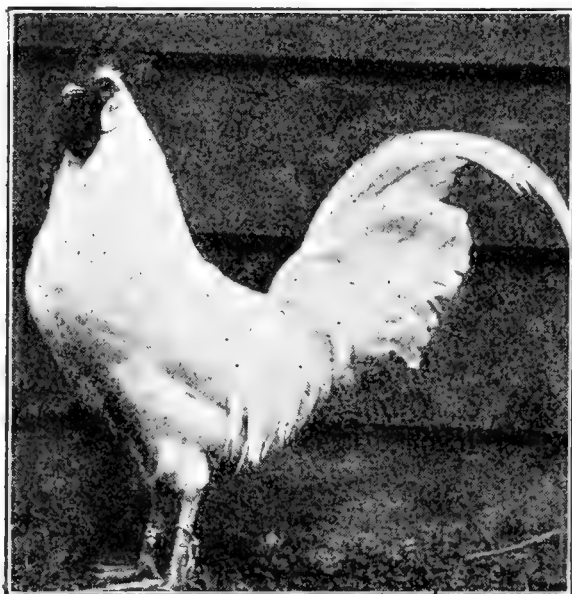
A complete classification and description of poultry is given in “Standard of Perfection,” the authoritative book on poultry.

Characteristics of the Mediterranean Class.— The different breeds comprising the Mediterranean class are comparatively small in size, and in weight. The

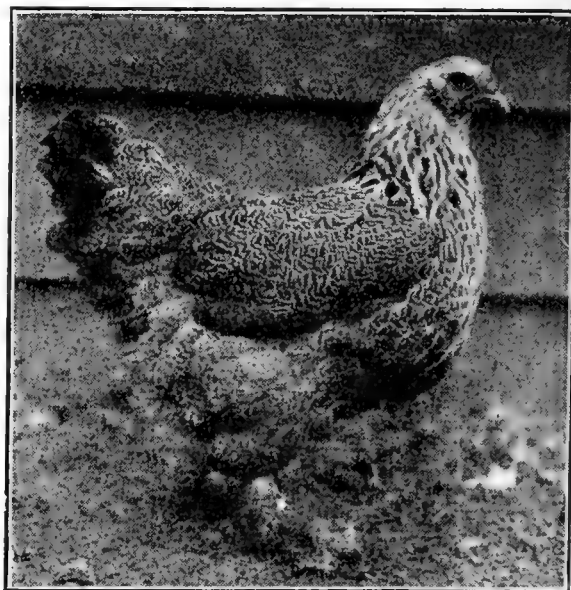
CLASSES	BREEDS	VARIETIES
1. Mediterranean (Egg Breeds)	1. Leghorns	{ Single comb; White, Brown, Buff Rose comb; White, Brown, Buff
	2. Minorcas	{ Single comb; Black, White, Buff Rose comb; Black, White
	3. Anconas	{ Single comb; Rose comb;
2. Asiatic (Meat Breeds)	1. Brahmas	{ Light, Dark
	2. Cochins	{ Buff, Black, Partridge, White
	3. Langshans	{ Black, White
3. American (General Purpose)	1. Plymouth Rocks	{ Banded, White, Buff, Silver Penciled Columbian, Partridge
	2. Wyandottes	{ White, Buff, Golden, Columbian Partridge, Silver Penciled
	3. Rhode Island Reds	{ Rose comb, Single comb
4. English (General Purpose)	1. Orpingtons	{ Buff, Black, White, Blue
	2. Dorkings	{ White, Silver-gray, Colored

birds are active, nervous, excellent foragers, and good layers. They make poor sitters, and are not often used to raise chicks. All the breeds lay white eggs, and have no feathers on their shanks or legs. There are both the single and the rose comb varieties. They are primarily raised for egg production. .

Characteristics of the Asiatic Class.— The breeds of the Asiatic class are easily distinguished from all other

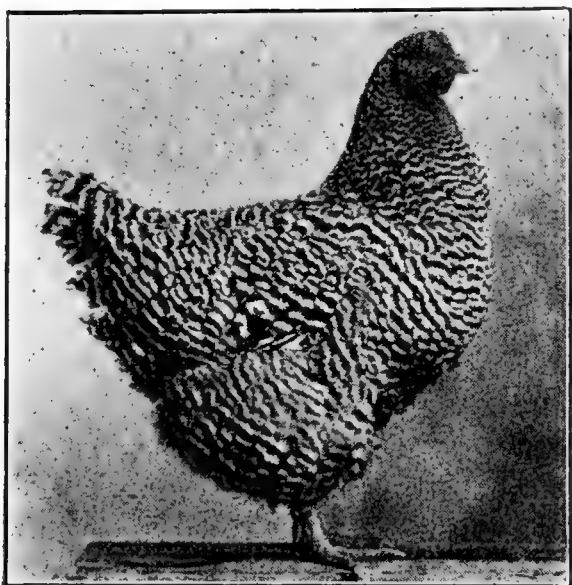


WHITE LEGHORN



BRAHMA

breeds of poultry by their size, and by the feathers they have on their shanks. The birds are very heavy, rather



BARRED PLYMOUTH ROCK



WHITE WYANDOTTE

inactive, poor foragers, and not nervous. They lay brown eggs, and make fair sitters and mothers. The

Brahmas have pea combs; the Cochins and Langshans have single combs. They are primarily raised for table fowls.

Characteristics of the American Class.—The different breeds of poultry of the American class are the commonest and most widely distributed. They are of medium size, fatten fairly well for table use, and at the same time are good layers. They are sometimes called the dual purpose breeds, a name which describes them very well. They have no feathers on their shanks. The birds are active, not nervous, fairly good foragers, and they make good sitters and mothers. They lay eggs having a light brown color.



A WHITE ORPINGTON
Courtesy of the American Poultry Journal

Characteristics of the English Class.—The birds of this class resemble those of the American class in size, form and utility. They are a distinct dual purpose fowl.

218. Egg Production.—There is not the difference in egg production between the breeds of the different classes of poultry, which there is commonly supposed to be. The difference is due entirely to the breeding; and the strain means much more than either breed or variety.

In a recent Egg-Laying Contest at the Connecticut Agricultural College,

350 Leghorns	averaged	165	eggs	in	one	year
210 R. I. Reds	"	158	"	"	"	"
170 Wyandottes	"	169	"	"	"	"
170 Plymouth Rocks	"	160	"	"	"	"
100 Miscellaneous	"	147	"	"	"	"

The thousand pullets in the contest averaged 162 eggs in one year.

219. Making a Start With Poultry.—Most failures with poultry are undoubtedly due to lack of experience, and to lack of knowledge about poultry management. Rarely does any one who knows the business thoroughly, and loves the work, make a failure. Below are some general suggestions for the beginner:

1. Start in the fall with 6 or 12 pullets from a good egg laying strain.
2. Be sure that these pullets are free of disease and pests, and come from a healthy flock.
3. Provide a warm house for the flock.
4. Feed them properly.
5. Keep accurate accounts.
6. If successful with a small flock, gradually enlarge the number of birds.

220. Locating the Poultry House.—The best location for a poultry house is on a slightly elevated site having a southern exposure. The site should have good drainage. Dampness and lack of sunshine are great detriments to the poultry raiser. The south side of an orchard, where the ground is slightly elevated, is undoubtedly one of the best places for the poultry

house. This gives sunlight, excellent range, and shade in the summer.

221. Essentials of a Good Poultry House.—A good poultry house need not be expensive. It should be well ventilated, free from draughts, dry, and so built that much sunlight can enter it. Nothing produces more disease among poultry than a damp, dark, and poorly ventilated house. The south side of the house should



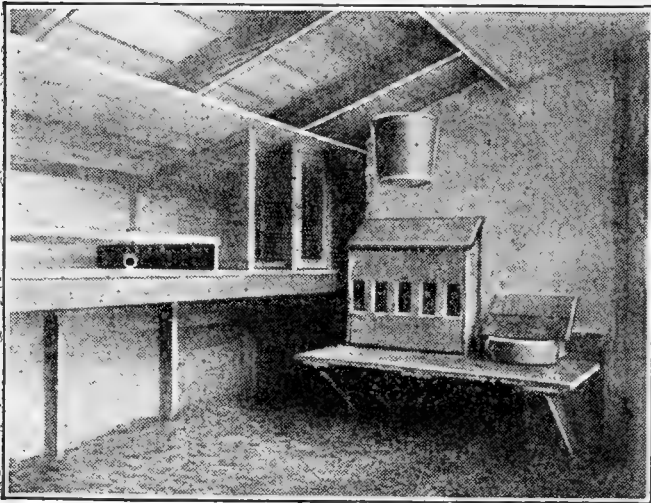
Courtesy of the International Harvester Company

either be open, have two or three large windows, or several windows and a large ventilator. The openings may easily be covered with muslin during the cold winter nights. This provides good ventilation, and yet keeps the house fairly warm. The floor of the poultry house should be either of cement or of matched board flooring, laid upon a thick layer of crushed rock or cinders, to break the capillary rise of moisture. The house should be deep, ten feet or more, and wide enough to accommodate the flock comfortably. Usually about five square feet of floor space should be allowed for each bird.

222. Styles of Poultry Houses.—There are very many styles or kinds of poultry houses, and, if correctly built, most of them are very satisfactory. The house

having a shed roof, eight to nine feet high in the front and four and one-half to five feet high in the back, is the commonest style, and answers the purpose very well. Such a house is easily built, and the least expensive.

223. Interior of a Good Poultry House.—A dropping board should extend across the back of the



CONVENIENT ARRANGEMENT OF THE INTERIOR.—*Courtesy of the Indiana Experiment Station.*

house 2 to 3 feet above the floor; and wide enough to accommodate the roosts. The roosts should be made out of 2" x 2" lumber, allowing 10 inches to each bird. A convenient place for the nests is underneath the dropping board, at the outer

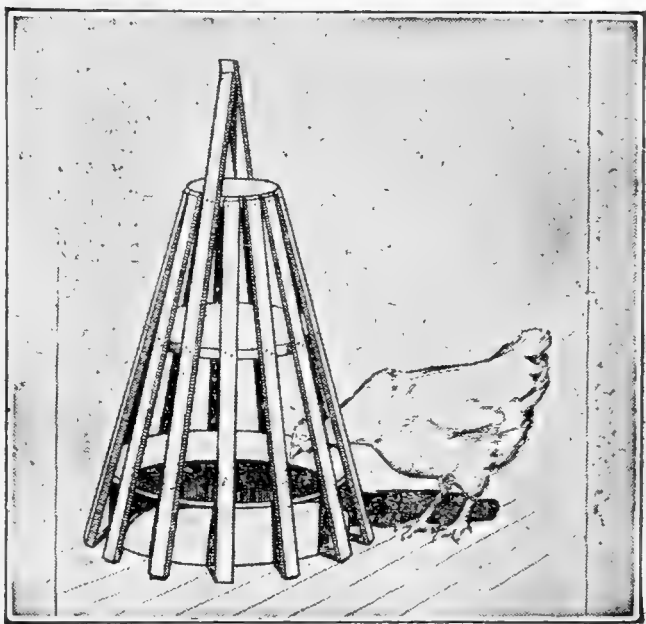
edge, or at one side of the house. These nests should measure about 14 inches each way, and should be about 2 feet above the floor. There should be one nest for about every four birds. Platforms along the sides of the house form an ideal place for feed and grit hoppers, and for water pans. These platforms should be about two feet above the floor. Such an arrangement of roosts, nests, dropping board and feeding platforms permits an entirely free floor space, which should be covered with dry, clean, coarse litter, preferably straw. In this litter the scratch feed may be scattered so that the birds will have to exercise to get it. In a house of this kind,

it is possible to keep the birds closed up during all unpleasant weather. All the interior fixtures, dropping board, feeding platforms, nests, and roosts, should be so built that they may be removed easily when necessary.

224. Feeding Laying Hens.—The feed for poultry may be divided into seven classes which are:—

- | | |
|--|------------------|
| 1. Grains or scratch feeds | 4. Green feed. |
| 2. Mill products or mashes | 5. Water |
| 3. Animal products such as meat scraps,
sour milk, buttermilk, etc. | 6. Lime and grit |
| | 7. Charcoal |

In the spring, summer, and fall, when the birds are on ample free range and are allowed to roam over the farm, they pick up a large part of all these necessary food materials, and the problem of feeding them becomes simple, if the number of birds is not very large. During these seasons of the year the birds get a large part of their protein from bugs, worms and insects. Gravel and sand forms their grit, and the green vegetation is the source of their green feed. In addition to this, they pick up considerable grain and much waste material. Nevertheless, they should be fed some grain,



DEVICE FOR PROTECTING MILK OR WATER PAN.—*Courtesy of the International Harvester Company.*

mostly in the evening, and it may be profitable to keep the dry mash hoppers open for them a short time each day, but this mash need contain very little meat meal. Skim milk and buttermilk may profitably be fed at all times if available. Fresh water, crushed oyster shells, and charcoal should be before them all the time. During the winter, and in the summer if the birds are confined, all their feed must be supplied to them if good results are expected.

Grains.— The grains most commonly fed to poultry are whole or coarsely cracked corn, wheat, oats, and barley. In a recent International Egg Laying Contest equal parts of cracked corn and of whole wheat were the only grains fed to the hens during the entire year of the contest. The grains are commonly fed in litter about six inches deep, so that the hens will have to scratch for the feed. Usually about one quart of grain is fed both in the morning and in the evening to each twenty hens. Sometimes a little more is fed in the evening than in the morning.

The Mash.— The mash is commonly fed dry from a self feeding hopper, as this is the least expensive way of feeding it. Occasionally, especially during the winter, hot wet mashes are fed to poultry.

The simplest dry mash is one made of equal parts by weight of

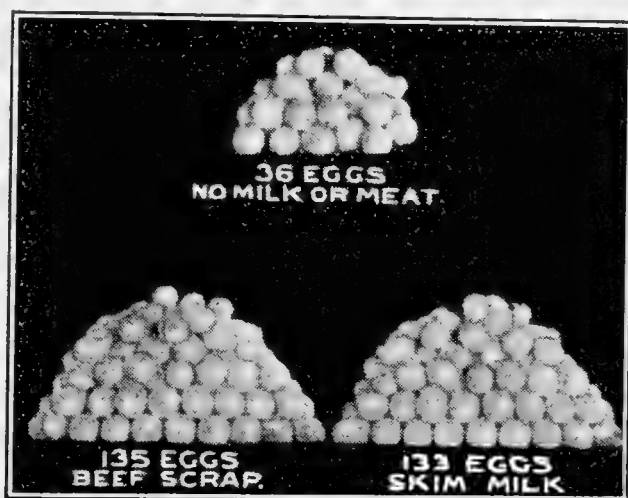
wheat bran	flour middlings	meat or
ground oats	corn meal	beef scraps

Unless a large flock is kept, it does not pay to make the mash, but one should buy a prepared mixed mash,

many kinds of which are on the market. If moist mashes are fed, and if these are made with some form of milk, no meat or beef scraps need be fed. It has been proved by many recent experiments with laying hens, that some form of animal feed, to supply protein, is necessary for good egg production.

Importance of Animal Protein.—At the Missouri Experiment Station three pens each of twenty-five laying hens, were fed for one year, November 1, 1914, to October 31, 1915, exactly alike, with the exception that one pen was fed sour skim milk in pans and in the mash, another pen received beef scraps in the dry mash, and the third pen received neither milk or beef scraps. The average number of eggs produced per hen were:

Skim milk pen	Beef scrap pen	No animal feed pen
131 eggs	107 eggs	55 eggs



Courtesy of the Indiana Experiment Station.

In a similar experiment at the Indiana Experiment Station, the following results were obtained:

Beef scrap pen	Skim milk pen	No milk, no meat pen
135 eggs per hen	133 eggs per hen	36 eggs per hen

These experiments show that some form of animal protein is essential for good egg production.

225. Broody Hens.—All broody hens, if not desired for sitting purposes, should be broken of their broodiness as soon as possible, in order to get them to laying again. This can be done by confining them in slat or wire coops in the poultry yard during the warm weather, or in the poultry house during the winter. Such a coop should have a slat bottom and be raised above the ground, or the dropping board, so that the hen cannot find a warm place to brood. If such a hen is supplied with considerable water and feed, and if the coop is so placed that the hen in it can see the other chickens, she will get restless and soon forget her broodiness. After four or five days of this confinement she may be released, and the desire to brood will have left her.

Experiments have shown that laying hens, confined in broody coops the first day they show symptoms of broodiness will start to lay again in ten days, from the time that they laid their last egg. If broody ten days, the interval between the last egg laid, and the first after the broodiness has been overcome, has been twenty-five days; and the longer the hen is broody, the longer will be the time before she will lay again.

226. Care of Eggs.—Infertile eggs keep much better and longer than fertile ones; for this reason the male birds should either be disposed of, or separated from the hens, after the breeding season is over.

If the nests are kept clean and free of pests, most of the hens will lay in the poultry house, and the gather-

ing of the eggs will be easily done. All eggs should be collected at least once a day, and immediately stored in a cool place.

227. The Breeding Flock.—If one has a small flock, in which every hen is a strong, vigorous bird that has been a good layer, no special breeding flock or pen is necessary. Most poultry men, however, separate their best hens during the breeding season and confine them with choice male birds in a separate pen called the breeding pen. The best hens are those which have been the strongest, most active, the best foragers, and which have laid the most eggs during the year. Such hens are always busy. They rise early and go to roost late. High egg producers, in the breeds having yellow shanks, lose much of their yellow color and their shanks become whitish. The late molters, the hens with bright red and soft combs, and the hens with broad deep bodies, usually possess the characteristics of good laying hens. If the records of such hens are known, so much the better. Only the best should be used to produce eggs for hatching, if advancement and improvement of the flock is desired. Selecting any egg from any hen never developed a good egg laying or show strain of poultry.

228. Pelvic Bone Test.—If the pelvic bones of a hen are found spread far enough apart so that two or three fingers may be placed between them, this is a fair indication that the hen is in a condition to lay. If these bones are so close together that only one finger may be placed between them, the hen is not in a laying condition. Thin and flexible pelvic bones are characteristics of a good layer.

229. Hatching Chicks.— There are, as you already know, two ways of hatching and brooding chicks, the natural and the artificial. In the natural way the chicks are hatched and raised by hens, and in the artificial way, incubators and brooders are used. The method to be used depends entirely upon the number of chicks one wishes to raise. If one wishes to hatch only a few sittings of eggs, the Rhode Island Reds are considered about the best hens for this purpose.

Hatching Chicks with Hens.— From thirteen to fifteen eggs usually make a sitting. These should be clean, fresh eggs of a good shape and size. The hen should have a convenient and comfortable nest. The nest should be placed in a quiet and somewhat secluded place. Whole corn and water should either be before the hen all the time, or they should be given to her every day. No other food is necessary. At the end of six or seven days, the eggs should be candled. The infertile eggs will be clear, while the fertile or good ones will show dark streaks about the yolks.

The Hatch.— When the chicks are dry, it is safe to remove them from underneath the hen and put them in a little box or basket lined with a piece of some soft, warm material such as flannel. This box should be kept near a fire in a warm room; and after all the eggs are hatched, the chicks may be given back to the mother hen and she should be well fed. In a day or two the hen and the chicks should be removed to the brooding coop. This coop should be clean, well disinfected, and should be kept continuously in a perfectly sanitary condition.

230. Feeding Chicks.— No feed should be given to the chicks until they are two days old. The space about them, or the floor of the house where they are kept, should be covered with coarse sand or fine grit. The first food should consist of some stale bread or crackers, moistened in milk, but having had the milk squeezed out of them so that when it is fed the food is in a crumbly condition. Johnny cake moistened with milk and fed in this way is also a very good feed. So are hard boiled eggs mixed with the bread. Water or sour milk, in saucers should be before the chicks all the time. For the first three or four days, after feeding is begun, chicks should be fed, as described, four or five times during each day and each feeding should consist only of such an amount as the chicks will clean up in about five to ten minutes' time.

After the chicks have been fed a day or two with the moist food, they may be given in addition a little coarse wheat bran and some fine oatmeal in a dry condition. This dry food should be kept before them. Later, chick feed may be scattered in the litter, and a dry mash kept before the chicks. The moist feeding should gradually be diminished until the chicks are about six weeks old, when they should have moist feed not more than once a day. It pays well to keep fine grit and charcoal before the growing chicks, and if it is available, skim milk, either sour or sweet.

When the chicks are about eight weeks old, they may be given free range. They should always be fed well, with a good ration, so that they may grow rapidly and be in a condition to start laying in the fall.

231. Poultry Diseases.— With poultry, as with all the other live stock, prevention of disease is always more important than curing disease. If the birds seem sick, and there are no external symptoms, it often pays to kill one, and to open it, in order to find out what troubled it. All birds which have died of sickness should be examined and then burned or buried so deeply that no animal can get at them. When the birds are inactive, that is stand around with their feathers ruffled up and their heads pulled back against their bodies, or if they are lame, or if their wings hang down, there is usually some disease in the flock, and the sick birds should be separated, to prevent further spreading of the malady.

QUESTIONS AND PROBLEMS

1. What breeds of poultry are most common in your community?
2. Which breed of poultry do you prefer? Why?
3. Why would it be more just to sell eggs by the pound than by the dozen?
4. What are the yearly egg records of some good laying hens in your community?
5. How many eggs should a good laying hen lay in one year?
6. Describe the interior arrangement of some good poultry house you have seen.
7. Why should a poultry house be ventilated?
8. What rations are being fed to poultry in your community? Criticize them.
9. Figure the cost of feed for 25 hens for one year; get assistance at home.
10. Assume that each hen lays 120 eggs a year and the aver-

age price of eggs is 25 cents, what is the return over feed in one year for 25 hens?

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Lessons on Poultry for Rural Schools, Bul. 464, 10 cents.

Commercial Fattening of Poultry, Bul. 21, 10 cents.

How to Kill and Bleed Market Poultry, Chem. Cir. 61, 5 cents.

System of Poultry Accounting, A. I. Cir. 176, 5 cents.

Organization of Girls' Poultry Clubs, A. I. Cir. 208, 5 cents.

Preventing Disease in Poultry, Yearbook, Sep., 559, 5 cents.

Winter Egg Production, Cir. 71, Office of The Sec., 5 cents.

Farmers' Bulletins.

Standard Varieties of Chickens, F. B. 51.

Boys' and Girls' Poultry Club, F. B. 562.

Poultry House Construction, F. B. 574.

Hints to Poultry Raisers, F. B. 528.

Incubation and Brooding, F. B. 585, F. B. 624.

Important Poultry Diseases, F. B. 530.

Poultry Management, F. B. 287.

Shipping Eggs by Parcel Post, F. B. 594.

A Simple Trap Nest, F. B. 682.

Preserving Eggs in Water Glass, F. B. 103.

Duck Raising, F. B. 697.

Goose Raising, F. B. 767.

Turkey Raising, F. B. 791.

Mites and Lice on Poultry, F. B. 801.

Standard Varieties of Chickens, F. B. 806, 898.

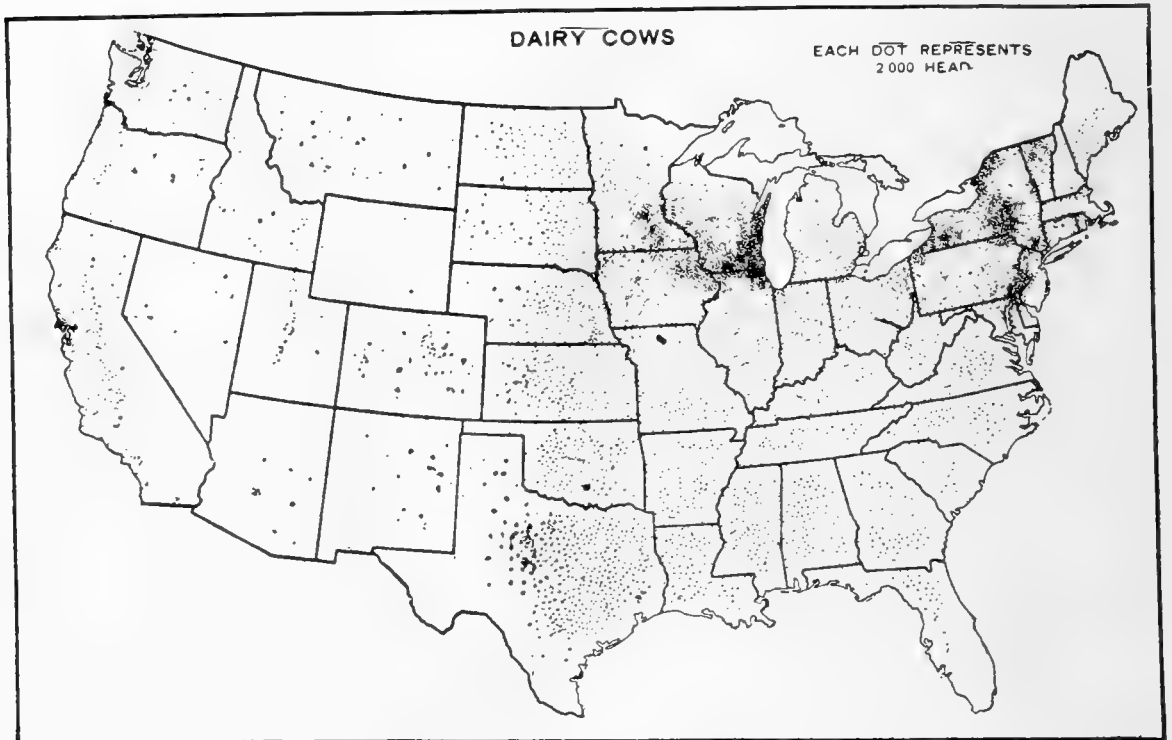
Marketing Eggs by Parcel Post, F. B. 830.

Back-Yard Poultry Keeping, F. B. 889.

CHAPTER XXIII

CATTLE

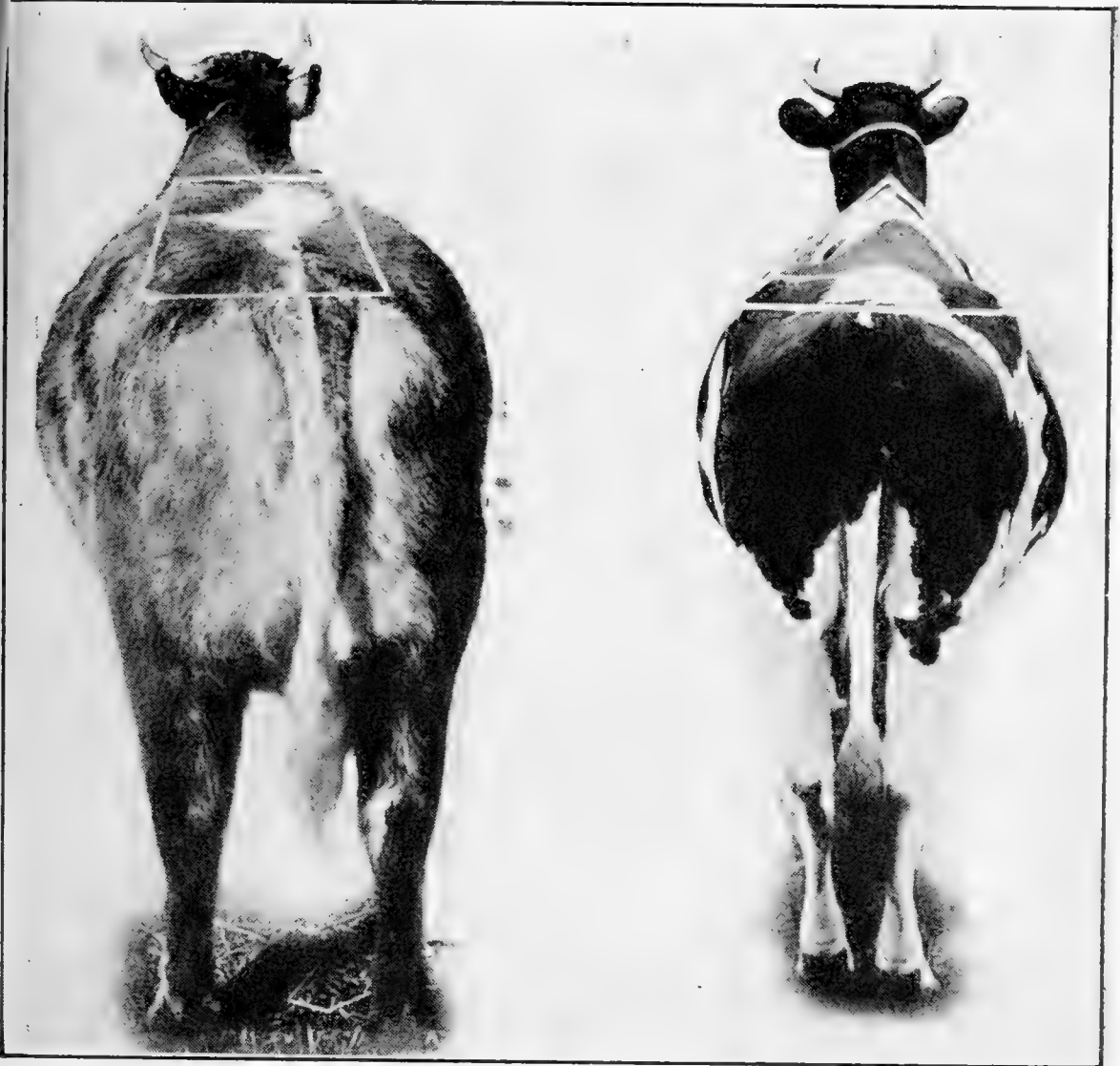
The animal industry is the most important branch of our agriculture. It is essential to a prosperous and permanent system of farming. Without it the maintenance of our soil fertility is difficult and expensive. Everywhere live stock farms produce much larger crop



Yearbook United States Department of Agriculture.

yields than do strictly grain producing farms. Live stock converts much coarse feed having a low market value into very nutritious animal products essential to human health. There are on our farms about 63 million cattle and of these nearly 23 million are milch cows.

232. **Advantages of Dairying.**—Dairying helps maintain the fertility of the soil. Dairy farmers feed to the cattle not only all the coarse feed and much of the grain produced on the farms, but they also purchase and



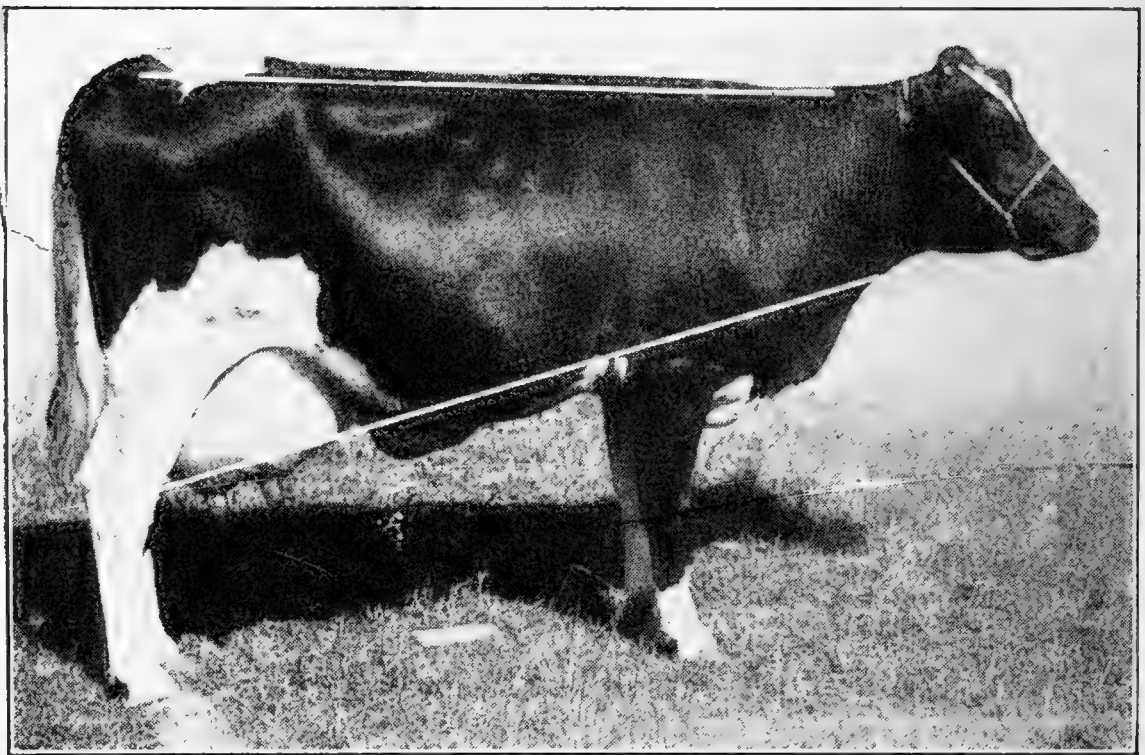
BEEF AND DAIRY TOP LINES

Beef animals utilize feed for developing a broad and thickly fleshed back. A triangular shaped back indicates dairy type and mild production.—*Wisconsin Bulletin 274*.

feed large amounts of rich concentrates, the manure of which contains much plant food. The cash returns from dairying continue through every month of the year and the farmers have a sure and constant source of revenue.

There is always a good market for dairy products. Dairying utilizes to the best advantage the farm labor during the entire year, especially if most of the cows freshen in the fall.

Dairying makes possible an ideal system of agriculture. In such a system every farmer sells certain amounts of his crops such as wheat, corn, potatoes, cotton, etc., feeds the remainder of the crops and the rough-



DAIRY TYPE.— *Wisconsin Bulletin 274.*

age to his stock, and returns most of the removed plant food to the soil. Our four leading dairy states are Wisconsin, New York, Iowa and Minnesota.

233. Types of Cattle.— Cattle are commonly classified in two groups or classes, called types, as, the dairy and the beef type.

234. The Dairy Type.— The dairy type, or class, of cattle includes the breeds which have been developed

primarily for milk production. The common dairy breeds of cattle are the

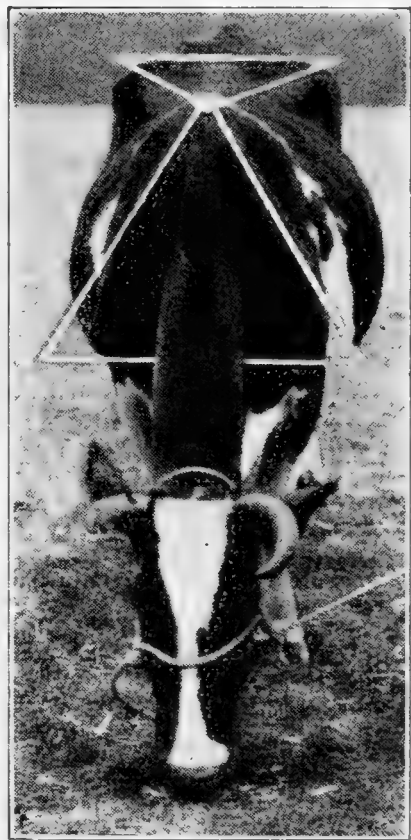
Jersey
Holstein

Guernsey
Ayrshire

Brown Swiss
Dutch Belted

The dairy type is characterized by leanness and angularity; and we commonly say that the cows show triple wedges, or have the "triple wedge conformation." These wedges are the *side-wedge* formed by lines along the back and along the underline of the body of the animal, the *front-wedge*, which is formed by lines from the top of the shoulders to the points of the shoulders, and the *top-wedge*, which is formed by lines from the hips to the tops of the shoulders, or withers. The triple wedge gives the animal a large abdominal and chest cavity, shows that it is lean and angular, and also gives ample room for the attachment of a large udder. All three of these points are essential characteristics for an efficient dairy cow, that is for a cow that can eat large quantities of feed and change it not into flesh, but into milk.

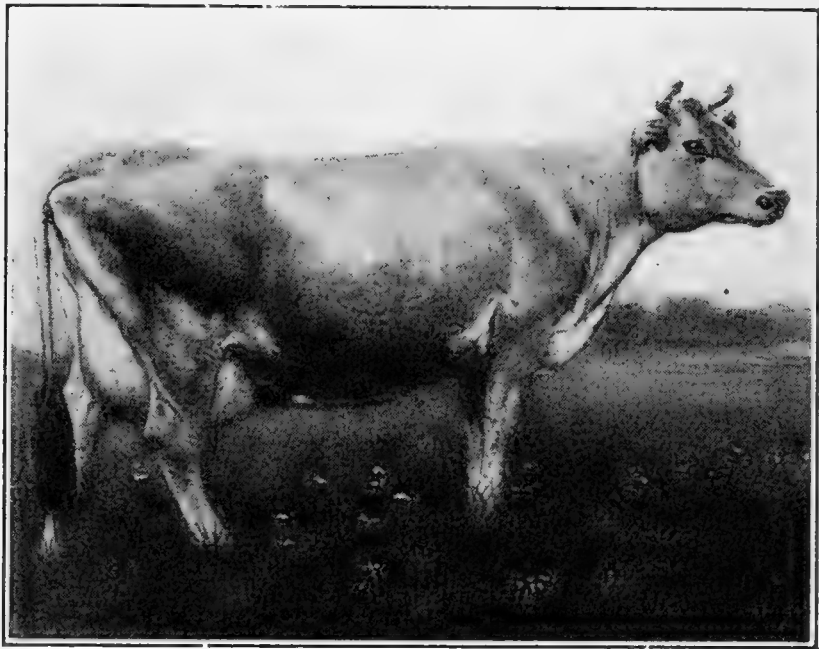
Jerseys. The Jerseys originated on the island of Jersey, one of the Channel Islands, near the coast of



LOOK FOR THE WEDGES

The body should be wedge shaped when viewed from the front and top of the withers, wider at the hip bones and at the floor of the chest than at the point of the withers.—
Wisconsin Bulletin 274.

France. The Jersey cattle are one of the most widely distributed breeds of dairy cattle, known everywhere for their rich milk, which has an average test of about 5.4 per cent. butter fat. The Jerseys are the smallest of the common, dairy breeds, the mature cows weighing from 750 to 1000 pounds. The color of the breed varies greatly, much more than does that of any other breed;



SOPHIE 19 OF HOOD FARM, A CHAMPION JERSEY COW

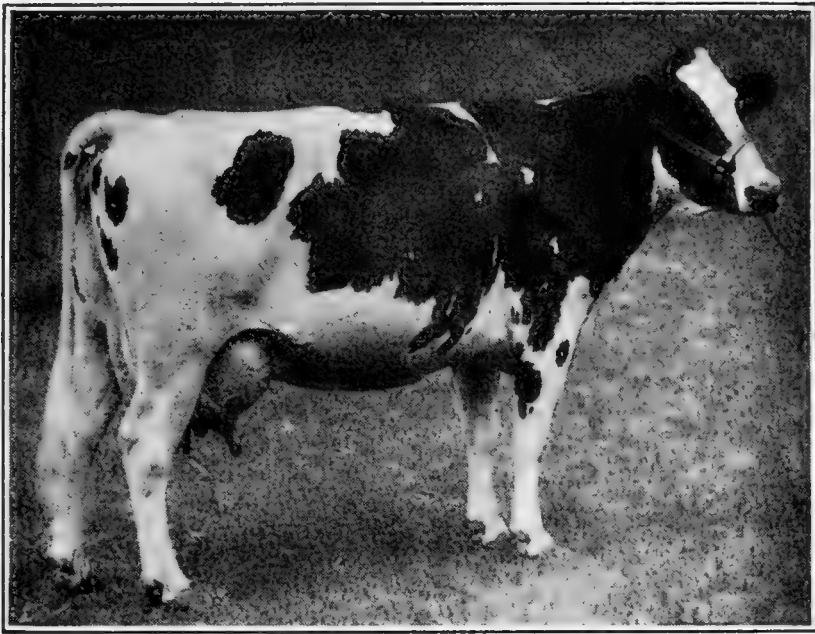
Year's record, 17,557 lbs. of milk; 999 lbs. of butter-fat.—*Courtesy of The De Laval Separator Company.*

it may be any shade of brown and even black, and any shade of yellow, fawn, and tan, or almost white. The muzzle is black or a dark lead color and is surrounded by a ring of light colored hair. Jerseys are persistent milkers, mature early, and are economical producers. The champion Jersey cow of the world, Sophies Agnes with a record of 16,212 pounds of milk, testing 6.168 per cent. and containing 1000.07 pounds of butter fat.

The Holsteins. The Holsteins are more correctly

called Holstein-Fresian cattle, because Holstein-Fresian is the name of the breed association in America. These cattle originated in Holland.

In color this breed of cattle is black and white, some almost entirely white. The Holsteins are the largest of all the dairy breeds, the cows averaging from 1000 to 1400 pounds. The cows are famous for the large quantity of milk they produce, which, however, is not



DUCHESS SKYLARK ORMSBY, CHAMPION HOLSTEIN COW

Year's record, 27,761.7 lbs. of milk; 1,205.091 lbs. of butter-fat.—
Courtesy of The DeLaval Separator Company.

nearly as rich as that of the Jerseys, averaging 3.5 per cent. butter fat. There is no breed of dairy cattle which has so many high producing cows as the Holstein-Fresian. The world's champion milk producing cow recently was a Holstein, Tilly Alcartra, which in one year produced 33428.8 pounds of milk containing 1058.39 pounds of butter fat. The world's champion, butter fat producing cow, recently, was Duchess Sky-

lark Ormsby, also a Holstein, which in one year produced 27,761.7 pounds of milk containing 1205.09 pounds of butter fat.

What was the average butter fat test of these two cows?

What are the records of some of the highest producing Holsteins in your community?

Guernseys. The Guernsey cattle originated on the island of Guernsey, which like Jersey, is also one of the



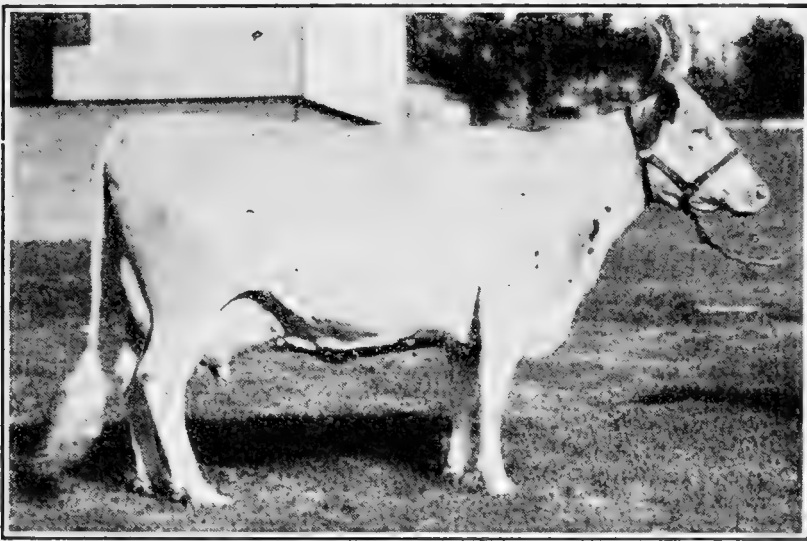
MURNE COWAN, CHAMPION GUERNSEY COW

Year's record, 24,008 lbs of milk; 1,098.18 lbs. of butter-fat.—*Courtesy of The DeLaval Separator Company.*

Channel Islands. Guernseys are larger than the Jerseys, though usually not as large as the Holsteins. The average weight of the cows is about 1000 pounds. In color they vary slightly, but the great majority are light yellow, or orange with white spots on the body and legs. The cows produce a rich milk having a slight yellow color, due to the deep yellow color of the butter fat. The average test of the milk is about 5 per cent.

The cows have a gentle disposition, are good milkers, and produce more milk than do the Jerseys. Recently a champion Guernsey cow, produced in one year 24,008 pounds of milk testing 4.57 per cent., and containing 1098.18 pounds of butter fat.

Ayrshires. The Ayrshire is a native of Scotland, where it is very hardy, being accustomed to roam long distances for its feed. It is sprightly and active, and well adapted for hilly pastures and hard conditions.

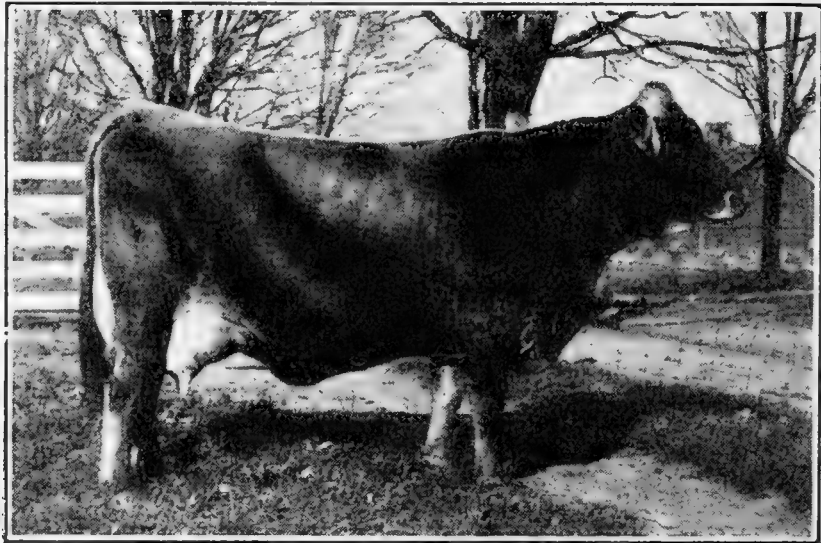


GARCLAUGH MAY MISCHIEF, CHAMPION AYRSHIRE COW

Year's record, 25,328.7 lbs. of milk; 897.87 lbs. of butter-fat.— *Courtesy of The DeLaval Separator Company.*

The color is usually red and white, the two colors not being mixed, but in patches. The Ayrshires have horns turning upward and outward in a manner different from all other breeds. The cows are slightly larger than the Guernseys, produce more milk, but not as rich milk, the average test being 3.6 to 4 per cent. butter-fat. A champion Ayrshire cow, produced in one year 23,022 pounds of milk, testing 3.99 per cent., and containing 917.6 pounds of butter fat.

Brown Swiss Cattle. The Brown Swiss cattle originated in Switzerland. In size these cattle are next to the Holsteins, the cows averaging about 1200 pounds; they are slightly more fleshy than the other breeds of dairy cattle, and for this reason the breed is sometimes classified with the dual purpose breeds. The predominating color is brown, but other colors or rather shades, such as light brown, and mouse color often occur. The



CHAMPION BROWN SWISS COW, COLLEGE BRAVURA 2D.

Produced in one year 19,460.06 lbs. of milk, containing 998.005 lbs. of butter-fat.—*Courtesy of The DeLaval Separator Company.*

nose, hoofs, and tongue are black. The breed is universally known for the long life the cattle attain, many of them being in their prime of life when ten years old. The cows are good milkers, giving milk which has an average test of about 4 per cent. butter fat. A champion Brown Swiss cow had a one year record of 19,460.6 pounds of milk, testing 4.1 per cent., and containing 798.16 pounds of butter fat.

Dutch Belted Cattle. The breed of dairy cattle, known as Dutch Belted, is characterized by a broad,

white belt encircling the body, while the remainder of the animal is black. This breed originated in Holland, and is not as widely distributed in America as are the other breeds. In size the Dutch Belted cattle resemble the Ayrshires, but are less fleshy. The cows are good



AUNT MACRINA 931 AND HER DAUGHTER, HAPPY THOUGHT 1540.—*Courtesy of The DeLaval Separator Company.*

milkers, giving milk having much the same qualities as Holstein milk.

What breeds of dairy cattle are most common in your community?

Which do you prefer? Why?

235. Pure Bred Animals.—We commonly speak of an animal as being either pure bred, a grade animal or a scrub animal. A *pure bred* animal is one that is eligible to registry or record in its respective breed association. Only the offspring of registered animals of the

same breed are eligible to registry. When this record has been made, the animal is a *registered animal*. When an animal has been thus registered in its breed association, a *certificate of registration* is issued and this certificate is the only official document to show that an animal is pure bred.

A *grade animal* is one having a pure bred sire and a non-pure bred dam. A *high grade* animal is one having 75 per cent. or more pure bred blood.

An animal, neither of whose parents were pure bred, is called a *scrub animal*.

236. Cow Testing Associations.— Every state now has cow testing associations. Each association, composed of from 20 to 30 farmers, engages a man to figure for the entire year the amount of milk and butter fat each cow produces, the cost of feed and the value of the produce for each cow in each herd. These associations have greatly helped in weeding out poor cows and in making dairying more profitable.

237. Judging Cattle.— The most accurate way of knowing the value of a cow is to weigh and test the milk she produces. In developing a herd of cattle, and in buying cattle, a good judge of them, is, of course, less apt to make mistakes than one who is not familiar with the external characteristics of good cattle.

The first essential in judging cattle is to learn the name and the location of the various parts usually considered in judging. The score card is a tabulation of these different parts; it describes the ideal condition of each, and assigns to each some numerical value. This value shows the relative importance of the different

DAIRY CATTLE SCORE CARD

SCALE OF POINTS	Pos- sible Score	Points Deficient	
		Stu- dents Score	Cor- rected
GENERAL APPEARANCE — 19 Points			
Weight, estimated....lbs., actual....lbs.....			
Form, wedge shape as viewed from front, side and top	5	.....	.....
Quality, hair fine, soft; skin mellow, loose, medium thickness, secretion yellow; bone clean, fine	5	.....	.....
Temperament, nervous, indicated by marked refinement in head, neck and forequarters; back bone prominent	6	.....	.....
Condition, healthy, spare fleshed	3	.....	.....
HEAD AND NECK — 10 Points			
Muzzle, clean cut, mouth large, nostrils large, wide apart	2	.....	.....
Eyes, large, bright, full	2	.....	.....
Face, clear cut, medium length, quiet expression, slightly dishing	1	.....	.....
Forehead, broad, slightly dishing.....	1	.....	.....
Ears, medium size, yellow inside, fine texture	1	.....	.....
Neck, fine, medium length; throat clean; light dewlap	3	.....	.....
FOREQUARTERS — 6 Points			
Shoulders, light, sloping, narrow at top.....	3	.....	.....
Brisket, light	1	.....	.....
Legs, straight, short; shank fine, feet sound.	2	.....	.....
BODY — 23 Points			
Chest, deep and moderately wide.....	5	.....	.....
Ribs, deep, wide apart, well sprung.....	4	.....	.....
Back, strong, prominent, spinal processes, wide apart	3	.....	.....
Loin, broad, strong, with roomy coupling....	3	.....	.....
Barrel, deep, wide, very capacious.....	8	.....	.....
HINDQUARTERS — 42 Points			
Hips, far apart, prominent; level with the back	2	.....	.....
Rump, long, wide; straight or slightly rising; pelvis roomy	4	.....	.....
Pin Bones, high, wide apart	1	.....	.....
Tail, set high, long, tapering, heavy switch...	1	.....	.....
Thighs, thin, long, wide apart; twist very open	4	.....	.....
Escutcheon, spreading over thighs, extending high and wide, large thigh ovals.....	1	.....	.....
Udder, broad, symmetrical, extending well forward, well up between the thighs, free from fleshiness, well held up, and quarters even in size	18	.....	.....
Teats, good size, evenly placed.....	4	.....	.....
Milk Veins, large, tortuous, branching, milk wells large, numerous	5	.....	.....
Legs, straight, far apart; shank fine, feet sound	2	.....	.....
Total	100	.....	.....

parts. In judging an animal with a score card, one makes deductions from the perfect score, equivalent to the degree to which he considers the animal being scored differs from the ideal animal, perfect in every point. It is necessary that one have in mind a mental image of a perfect animal. This may be derived partly from the description on the score card, partly from pictures and illustrations and partly from having seen good cattle. With this mental picture before one, judging becomes a process of comparison, and the score card is the guide to aid in the work. The score card is always used in learning how to judge cattle. After one has used this method long enough so that he will not overlook any of the important points, he will be able to judge a group of cattle fairly well without the score card.

Placing Animals.— In any contest or in judging any group of animals, it is necessary to rank or place the animals, that is, to pick out the first, second and third best, etc., in order. In such work the score card, when used, is only regarded as a general guide. Because it is too laborious and takes too much time to score each animal in detail, a quicker way must be used. Consequently, all the animals to be judged, are looked over carefully, one or more times, and one is selected as the most perfect of the lot. Then the second best is picked out and so on, until all the animals are ranked. In all judging contests, where a number or group of some breed of animals is judged, the method just described is used, but usually reasons for placing or ranking the animals must be given. For instance, let us say there

are ten cows, numbered from 1 to 10, before us, and we wish not only to pick out in order of their excellence, the best three, but to state our reasons for ranking the animals as we do. The reasons we give to support our judgment must be brief, must be important, and must show the most striking differences between the animals. Let us assume that we rank cow 5, first, cow 1, second, and cow 6, third. Reasons for placing the animals as we do may be indicated as follows:

First.

We place cow 5 first because she has the largest barrel, the largest udder, and the largest milk veins and wells. Therefore, she appears to have the greatest capacity for feed, and for milk production, and the strongest circulatory system.

Second.

We place cow 1 before cow 6 because she shows a better dairy conformation, is more wedge shaped, more angular, is larger, and has a greater capacity for feed.

Third.

We place cow 6 third, because she has a larger barrel, a better udder, and a better dairy temperament, than any of the remaining cows. Her skin is soft and pliable, and her milk veins are fairly well developed.

It must be remembered that these reasons must never be mere comparisons which do not exist, nor an enumeration of some common minor points, but they must actually show the most important differences between the cows which are being judged.

238. How to Keep Records.—To keep milk and butter fat records of a herd, use a spring balance, sev-

eral pint glass jars, a small sampling dipper, some preserving tablets, a Babcock milk testing outfit, and a record sheet. Tack the record sheet up in a convenient place; weigh the milk and record the weight in the proper column after each milking. Put samples from two or three consecutive milkings into a glass jar which already contains a preserving tablet. If the milk is tested within a short time the preserving tablet is not needed. By means of these samples, test the milk once a week or once or twice a month, and determine the amount of butter fat produced. Finally, from these weekly or monthly records, compute the year's production.

239. Feeding Dairy Cattle.— The feeding of dairy cattle has been fully discussed in Chapter XXI. Feeding standards for dairy cattle have been carefully formulated by experimentation. A farmer should learn to calculate the feed requirements for his cows and should use these standards as guides in formulating the best and cheapest rations for the cattle, making the best possible use of the home grown feeds. Cows on pasture will give more milk if fed some concentrates. These concentrates increase the cost of producing the milk, but since the additional feed is usually well paid for in increased yields of milk, concentrates should be fed whenever a greater production is desired. Short pastures should be supplemented by good feeds such as soil-ing crops, silage, hay and concentrates, if good results are desired. In the winter and in the absence of any pasture, balanced rations should be fed, if good milk yields are expected. Many farmers consider the balanc-

ing of rations too difficult, but as has already been stated, the process is simple if clearly understood.

240. Raising the Calf.—The calf is commonly allowed to run with the cow for the first two to four days of its life; after that it is separated from the mother and put into a calf pen. The following method of feeding calves is used quite extensively:

Calves under one month of age:

2½ to 4½ lbs. of warm skim milk 3 times a day.

From 1 to 2 months of age:

4 to 6 lbs. of warm skim milk 3 times a day.

1 to 2 handfuls of a grain mixture fed dry from a box.

Small amounts of mixed hay.

From 2 to 4 months:

6 to 10 lbs. of warm skim milk twice a day.

2 to 3 handfuls of a grain mixture.

Silage leaves — small amount; mixed hay kept before the calf all day.

From 4 to 8 months:

8 to 12 lbs. of warm skim milk twice a day.

½ to 1 lb. of a grain mixture.

Silage — 4 to 8 lbs. per day.

Clover or alfalfa hay kept before the calf all day.

Thereafter:

Skim milk if available.

2 lbs. of a grain mixture per day.

7 to 8 lbs. of silage.

Clover or alfalfa hay kept before the calf all day.

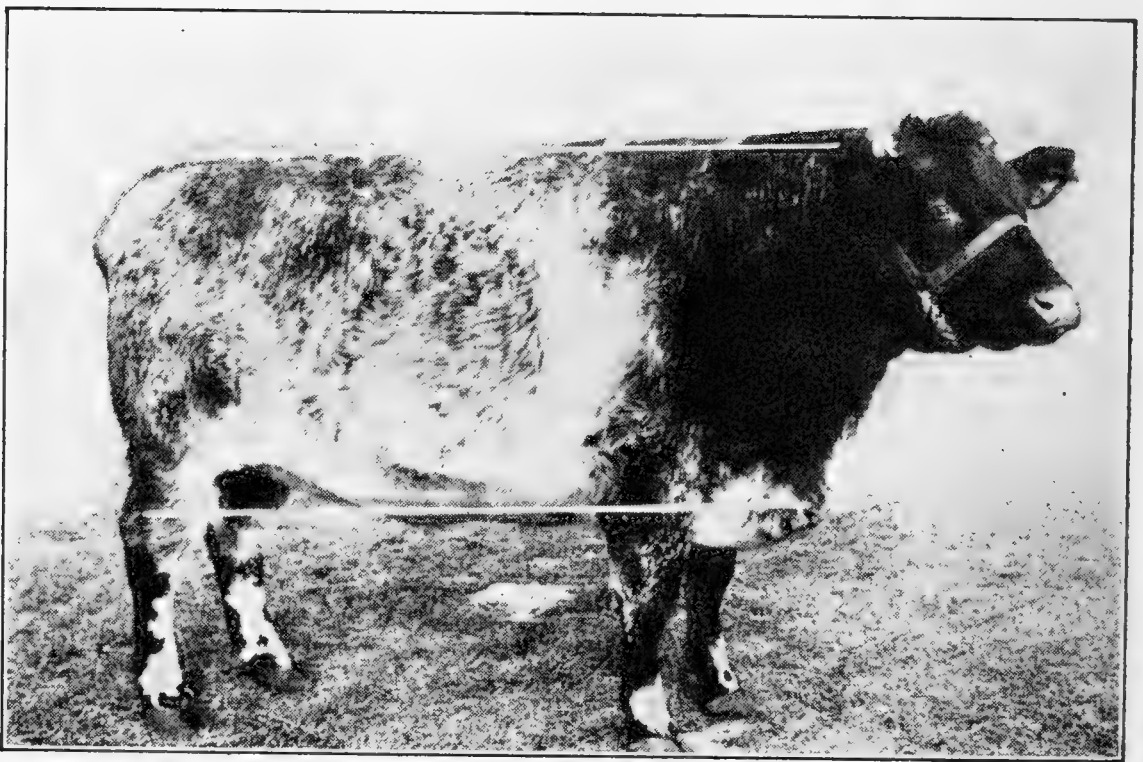
Calves are usually not turned out on pasture when young but are kept in the barn and well fed, and turned out for exercise only late in the afternoons and during the nights. The skim milk, if available, may be fed very profitably to calves until they are a year old. The

amount of grain is gradually increased until the calves, by the time they are two years old, are receiving not more than three pounds per day.

241. Beef Cattle.—The industry of raising beef cattle to supply the markets with a good quality of meat, is rapidly increasing; and, as in dairying, the value of good stock and of good sires to produce choice, early maturing steers, is given much consideration. The four common breeds of beef cattle are:

Shorthorns
Herefords

Angus
Galloway



BEEF TYPE

A Shorthorn.— *Wisconsin Bulletin* 274.

242. The Beef Type.—We have in a general way already described the beef type of animal. It is important that beef cattle do differ in form from the dairy cattle. The general form of the beef animal is broad,

deep, compact and smooth. Viewed from almost any point, the body should show a rectangular or parallelogram shape. The legs are short; the loins, back and chest are thickly covered with flesh. The angularity, characteristic of the dairy type, does not appear.

Shorthorns.—The Shorthorns are sometimes called



HEREFORD COW

Durhams. They are the most popular breed of beef cattle in the United States. They have short, pointed horns, and the color of the breed may be red, red and white, pure white, or roan. A roan color in cattle signifies the presence of Shorthorn blood. The Shorthorns are the largest sized breed of beef cattle, the bulls attaining a weight of 1800 to 2200 pounds or more, and

the mature cows weighing from 1300 to 1600 pounds. The Shorthorns mature early, fatten readily, are fairly good grazers, and give more milk than the cows of the other beef breeds.

Herefords.— The Hereford breed of beef cattle ranks second in popularity. As “rustlers” on the range, and for sustaining their vitality under adverse conditions, the Hereford is surpassed by no breed of beef cattle.



VICTOR, GRAND CHAMPION STEER

An Aberdeen-Angus, considered the greatest steer ever shown at American shows.—*Courtesy of the American Aberdeen-Angus Breeders' Association.*

The Herefords are easily distinguished from the other breeds of cattle by their white faces and heads, throats, dewlaps, and underlines; the remainder of the animal is red. The weight of the Hereford cattle is practically the same as that of the Shorthorn. The breed is sometimes called White Face cattle.

Angus.— The Angus cattle are commonly called

Aberdeen-Angus, as this is the name of the breed association. The cattle are solid black and have no horns. We therefore say they are “polled,” meaning they are hornless. They are not considered as good grazers as the Herefords. They do, however, mature very early, and have a tendency to fatten readily while growing; this makes the breed popular for the production of baby beef. The Angus cattle are smoother, and they have a more cylindrical body, than do the Herefords and Shorthorns; also the percentage of meat on them is larger than in the other breeds.

Galloway.—The Galloway cattle are also solid black in color, and hornless or polled. They may be distinguished from the Angus cattle by their long, curly, silky coat. The breed matures more slowly than the Angus and the Hereford. The Gallo-



“PAT RYAN OF RED CLOUD”

1st Galloway Bull.—*Courtesy of the American Galloway Breeders' Association.*

way cattle, however, are good grazers and “rustlers,” and because of their long, curly coat of hair, they are popular in the Northwest and in Canada.

243. Dual Purpose Cattle.—The common breeds of cattle usually regarded as dual purpose breeds are:

Red Poll
Devon

Milking Shorthorns
Polled Durhams

244. Fattening Beef Cattle.—Fattening beef cattle and getting them ready for market is an art, just as feed-

ing dairy cattle is. In many localities where dairying is not practicable, and where the farms are so located that the marketing of crops is too expensive, the growing and fattening of beef cattle becomes important. Alfalfa hay, clover hay, and corn silage usually form the most economical roughages for fattening beef cattle. For concentrates, corn is most extensively used and this is supplemented with a little linseed or cottonseed meal. The feeding standard for fattening cattle, Table 6 Appendix, aids in balancing rations for fattening growing steers.

QUESTIONS AND PROBLEMS

1. Why should a dairy cow have a large stomach?
2. What are the advantages of hornless cattle? Does it pay to dehorn cattle?
3. What is gained by selling cream instead of beef from the farm?
4. What are the most common breeds of cattle in your community?
5. What breed of cattle is best for milk production? For butter fat? Why?
6. What are the advantages of winter dairying?
7. What is gained by being able to judge cattle?
8. What are a few rations actually being fed to dairy cattle in your community?
9. Using current local prices, what is the cost of one or two of these rations?
10. What would the rations cost for one year?

Farmers' Bulletins.

Breeds of Dairy Cattle, F. B. 106.

Breeds of Beef Cattle, F. B. 612.

The Dairy Herd, F. B. 55.

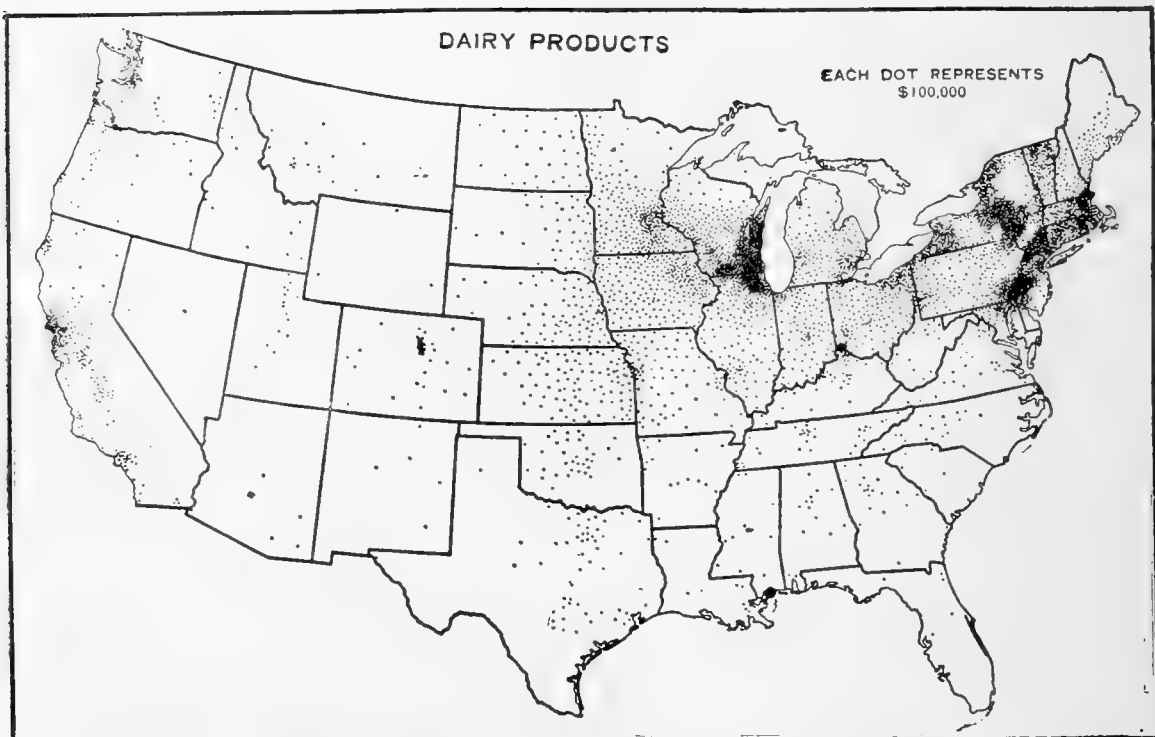
The Foot and Mouth Disease, F. B. 666.

- Some Essentials in Beef Production*, F. B. 71.
Milk Fever, F. B. 206.
Dehorning Cattle, F. B. 350.
Making and Feeding Silage, F. B. 578.
Economical Cattle Feeding in the Corn Belt, F. B. 588.
Feeding Dairy Cows, F. B. 743.
The Feeding of Dairy Cows, F. B. 743.
Breeds of Dairy Cattle, F. B. 893.
Cattle Lice and How to Eradicate Them, F. B. 909.

CHAPTER XXIV

MILK AND ITS PRODUCTS

245. **Milk as a Food.**—Milk is one of the most perfect foods for man, because it contains in excellent proportions all the nutrients and mineral substances needed by the body. It contains casein and albumin to



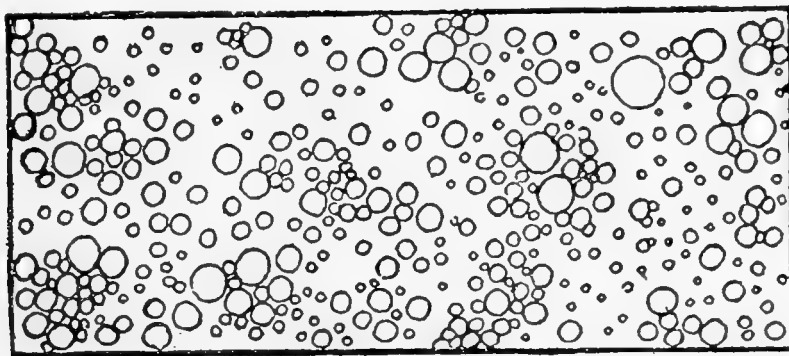
Yearbook of the Department of Agriculture.

form muscle and repair wastes, fat and sugar to produce heat and energy, and mineral salts to produce bones.

246. **Composition of Milk.**—The average composition of cow's milk is shown below:

Water	87%	Casein	2.6%
Fat	4%	Albumin .....	.7%
Milk sugar	5%	Mineral matter .....	.7%

Fat.—The fat, commonly called butter fat, is suspended in the milk in the form of an emulsion; the other ingredients, sugar, casein, albumin, and mineral salts,



MILK AS SEEN WITH COMPOUND MICROSCOPE

are dissolved in the water. The amount of butter fat in milk is variable, usually ranging from 3 to 6 per cent.

Milk Sugar.—Milk sugar is a carbohydrate, and as a food furnishes the body with fuel and energy. Milk sugar, or lactose, is usually seen in the form of a white powder, and is used and sold by druggists. It is not so sweet as ordinary sugar.

Casein.—The principal protein in milk is casein. This is dissolved in the water and gives milk the white color. In the making of cheese the casein is coagulated and the whey obtained is, as you know, not white. Casein furnishes material for the growth and the repair of tissues.

Albumin.—The other protein of milk is albumin. It occurs in much smaller quantities than does casein, and has the same function in nutrition. It is slowly

coagulated, when milk is heated, and it then rises and forms a thin, tough skin on the surface.

Mineral Matter.— Since milk is the principal food of young animals, we see a reason for its content of mineral matter or ash; this ash largely forms the bones of the young growing animals. The principal mineral compound is phosphate of lime.

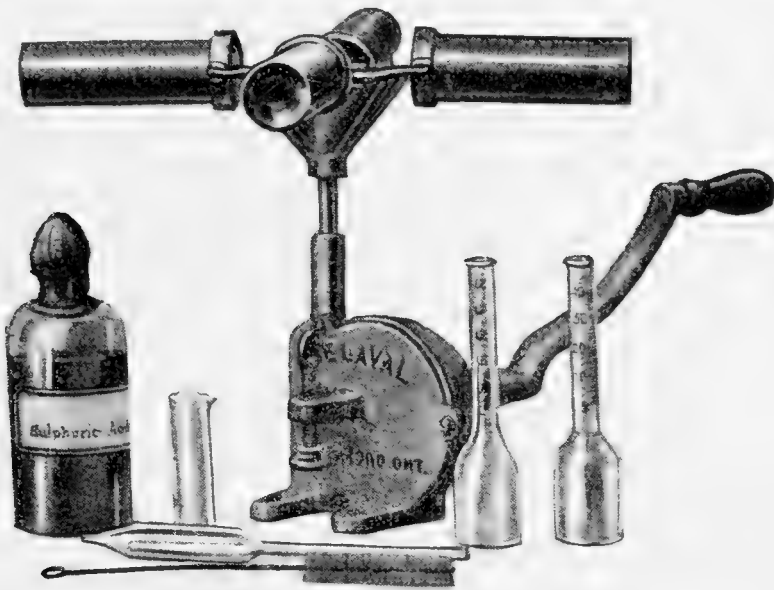
Colostrum.— The first milk given by a cow is called colostrum. It contains five or six times as much protein as does ordinary milk and should always go to the calf. It is not good for ordinary purposes, as other milk is.

247. The Souring of Milk.— The souring of milk is caused by bacteria. Some of these minute organisms are always present in milk, but many more come from the air, from milk pails, and from other utensils which are not kept absolutely clean. These bacteria act on the milk sugar and form an acid called lactic acid. When enough of this acid has accumulated, the casein coagulates, and the milk curdles. Milk is an especially good home for bacteria as it contains just the food and the moisture they need. When milk is at the right temperature, bacteria develop very fast.

248. Production of Clean Milk.— To avoid souring of milk, every precaution for cleanliness must be taken, and immediately after milking, the milk must be cooled to a low temperature to check the growth of the bacteria. Milk pails, cans, and bottles, as soon as emptied, should be washed in scalding water, and aired in the sun. If they can be sterilized by steam, so much the better. No work which stirs up dust, such as pitching hay, should be done in the barn just before milking.

Take two samples of milk from the same milking. Allow one sample to cool naturally, and cool the other at once by placing it in ice water. After two or three hours set both samples in a cool place and note which one sours first.

249. Importance of Butter Fat Test.— It is very important to know how much butter fat there is in milk. Everywhere, milk and cream are sold on a butter fat



A BABCOCK TESTING OUTFIT.— *Courtesy of The DeLaval Separator Company.*

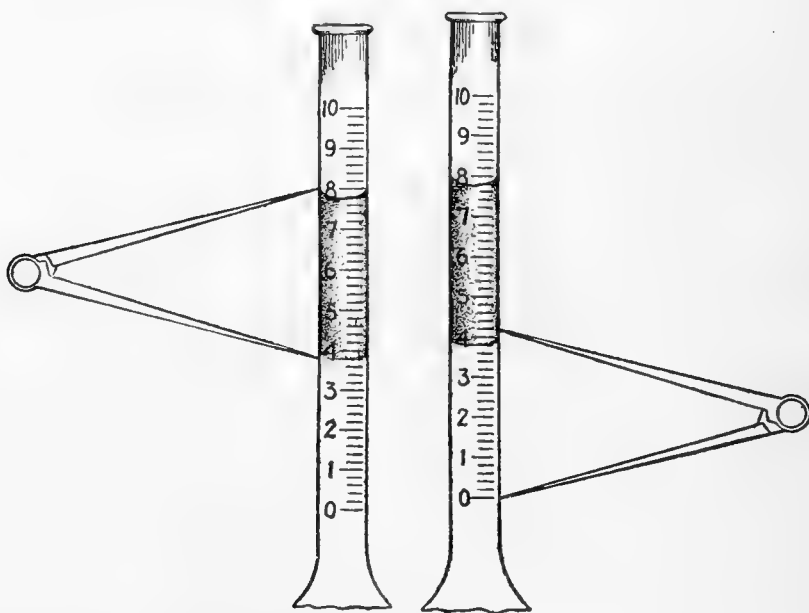
basis. That is, a condensory or creamery pays a certain amount for milk containing four per cent. butter fat, and pays more or less for other milk, according to the amount of butter fat it contains.

For example, if a condensery pays \$2.00 for 100 pounds of 4% milk, and three cents more or less for each additional or lacking 1/10% butter fat in the milk, then 100 pounds of 3.5% milk would be worth \$1.85, and 100 pounds of 5% milk would be worth \$2.30.

Like condenseries, creameries also buy milk and cream according to the amount of butter fat they contain, but their method is slightly different. They usually pay so much per pound of butter fat. The price is quite universally deter-

mined by the wholesale price of butter. For example, when butter at Elgin, Ill., is selling at wholesale for 35 cents per pound, a creamery which makes a practice of paying 2 cents above Elgin for butter fat, will pay 37 cents for one pound of butter fat in milk or cream.

All states and cities have ordinances which, by law, regulate the minimum of butter fat contained in milk sold for household purposes. Three to 3.5 per cent. is commonly the minimum.



Courtesy of The DeLaval Separator Company.

READING THE TEST

The dividers in the first position for reading the test.

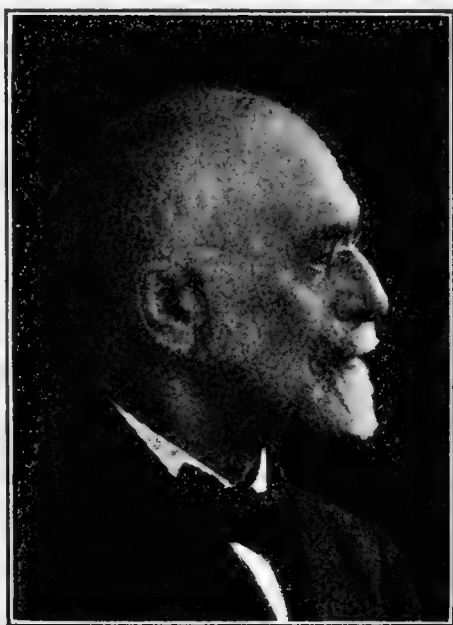
The dividers in the second position for reading the test.

In order to know the producing value of a dairy cow, one must know not only how much milk she produces, but how much butter fat there is in her milk. The amount of butter fat in milk can readily be determined by the Babcock test (see page 356).

250. The Milk or Babcock Test.—The Babcock testing outfit consists of a machine or tester, graduated

milk test bottles, a pipette, or milk measuring tube, some acid, and an acid measure. The tester is a machine in which the test bottle can be whirled rapidly enough for all the butter fat to be brought to the top. Usually 10 per cent. milk test bottles are used. These have long narrow necks and are graduated from 1 to 10 per cent. Since there are five small divisions in each per cent, each small division represents .2 per cent. The test is based upon 17.6 c.c. of milk which weighs approximately 18 grams. The pipette, or milk measuring tube, has a mark near the upper end which shows how much milk to draw up and to use. The pipettes are stamped 17.6 c.c. which indicates the proper amount of milk. The milk, however, could be weighed instead of measured, and 18 grams be used. Usually 17.5 c.c. is the correct volume. The acid used is strong or concentrated sulphuric acid, having a specific gravity of 1.82 to 1.83. When a very accurate test is desired a water-bath must be provided in which the milk bottle may be kept for five minutes before the test is read, in water having a temperature of 125 to 140 degrees F. The complete directions for testing milk are given in Table 8 of the Appendix.

Value of the Babcock Test.—The Babcock test was invented in 1890 by Professor S. M. Babcock of the



DR. BABCOCK

Inventor of the Babcock Test.—*Courtesy of the De-Laval Separator Company.*

University of Wisconsin. Before its invention, milk was all bought and sold on the weight basis alone. The man who produced rich milk and the one who produced poor milk both received the same amount of money for it. Since the Babcock test has been invented, dairying has been placed upon a business-like basis. It gives both the producer and the purchaser a square deal. Its universal use has brought about better cows, better milk, and most important of all, better dairying.

251. Cream.— That part of the milk into which most of the butter fat finally gathers is called cream. It may contain 15 per cent to 50 per cent butter fat. State laws specify the minimum amount of butter fat in cream sold for household purposes. This varies from 15 per cent to 20 per cent, but 18 per cent is the common minimum. Cream is lighter than the rest of the milk, and so the latter sinks to the bottom while the cream is pushed up. We say “the cream rises,” but in reality, it is pushed up.

252. Butter.— When cream has been tumbled about for a half hour or more in a churn, the particles of fat unite closely into small grains, which separate from the water and other parts of the milk, and become what we call butter. The average composition of butter is:

Butter fat	83%	Salt	2%
Water	14%	Protein and ash.....	1%

Butter is generally made from sour cream, one or more days old, because the flavor of such butter is considered by most persons more desirable than that of butter made from sweet cream. The cream previous

to churning is generally kept at a low temperature 40 to 50 degrees Fahrenheit, and the churning is done at a temperature of 50 to 54 degrees in summer and 54 to 58 or higher in the winter. Most persons demand that their butter be yellow, so butter is colored with annatto, a small quantity of which is added to the cream before churning.

All states have laws specifying the minimum of butter fat and the maximum amount of water in butter. Usually 82 per cent is the minimum of butter fat.

253. Cheese.— The same separation of casein, which is caused by the souring of milk, may be produced by adding rennet to milk. In cheese making, rennet is added to produce the curd. After the curd is properly formed by the help of heat, it is carefully cut into small pieces.

Heat is applied according to the kind of cheese which is being made, and according to the amount of acid desired. After the curd is formed, the whey is drawn off. This curd is then handled to make it solid and to drain off the surplus water. After this is done, the curd is run through a mill and cut into small pieces, is salted, put in forms or hoops, and pressed according to the kind of cheese which is being made. Finally, it is cured in a cool room for several weeks before it is ready for the market. The average composition of cheese is:

Water	37%	Casein	24%
Fat	34%	Ash	5%

Get a little rennet from a cheese factory. Add it to milk and observe the formation of curd.

The student should visit butter and cheese factories and observe the making of butter and cheese.

QUESTIONS AND PROBLEMS

1. Describe some of the precautions required to produce clean milk?
2. What is certified milk? Sanitary milk? Guaranteed milk?
3. Why is skim milk a more valuable food than whey?
4. What is the cost per pound of digestible nutrients in milk selling at 8 cents a quart; in buttermilk at 5 cents a gallon and in skim milk at 5 cents a gallon? Figure 1 pound to a pint in each case and use Table 2 in the Appendix.
5. How could milk from tubercular cattle be made safe for food?
6. Are the cattle in your community tested for tuberculosis?
7. Why should milk be cooled on the farm before it is shipped?
8. If 100 lbs. of 4% milk is separated into cream testing $33\frac{1}{3}\%$ butter fat and into skim milk containing no butter fat, what is the weight of the cream and the skim milk?
9. If a milk condensery pays \$2.10 for 100 lbs. of 4% milk and a creamery 45 cents a pound for butter fat and if 30 cents is allowed for the value of the skim milk in 100 lbs. of milk, what is gained by selling the milk to the condensery?

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Pasteurization of Milk, A. I. Cir. 197, 5 cents.

Extra Cost of Producing Clean Milk, A. I. Cir. 170, 5 cents.

Improved Methods of Producing Good Market Milk, A. I. Cir. 158, 5 cents.

Influence of Breed and Individuality on Composition of Milk, A. I. Bul. 156, 5 cents.

Influence of Stage of Lactation on Composition of Milk, A. I. Bul. 155, 10 cents.

Influence of Acidity of Cream on Flavor of Butter, A. I. Bul. 114, 10 cents.

Determination of Fat and Salt in Butter, A. I. Cir. 202, 5 cents.

Legal Standards for Dairy Products, A. I. Paper, 5 cents.

Pasteurization of Milk, Bul. 240, 5 cents.

Farmers' Bulletins

Bacteria in Milk, F. B. 490.

Production of Clean Milk, F. B. 530, 602.

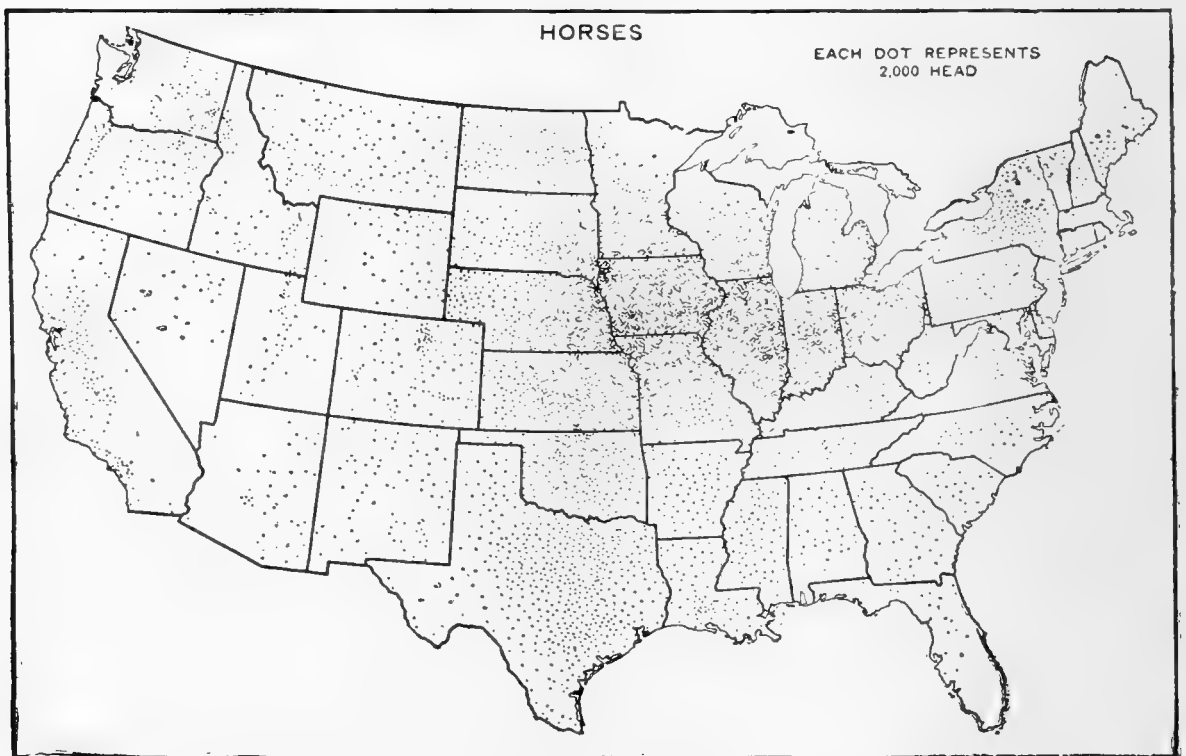
A Simple Steam Sterilizer for Dairy Utensils, F. B. 748.

Butter Making on the Farm, F. B. 241.

CHAPTER XXV

HORSES

254. Importance of Horses.— The horse is still the most valuable beast of labor in the world and will undoubtedly continue to be so on our farms. We may think that the day will come when we shall be able to



DISTRIBUTION OF HORSES.—*Yearbook of the Department of Agriculture.*

get along without horses, but judging from the United States census reports, that day is far distant, because there are still about 20 million horses and nearly 5 million mules on our farms

255. History and Types of Horses.— The horses in the United States are all descendants from horses imported into America from Europe and Arabia.

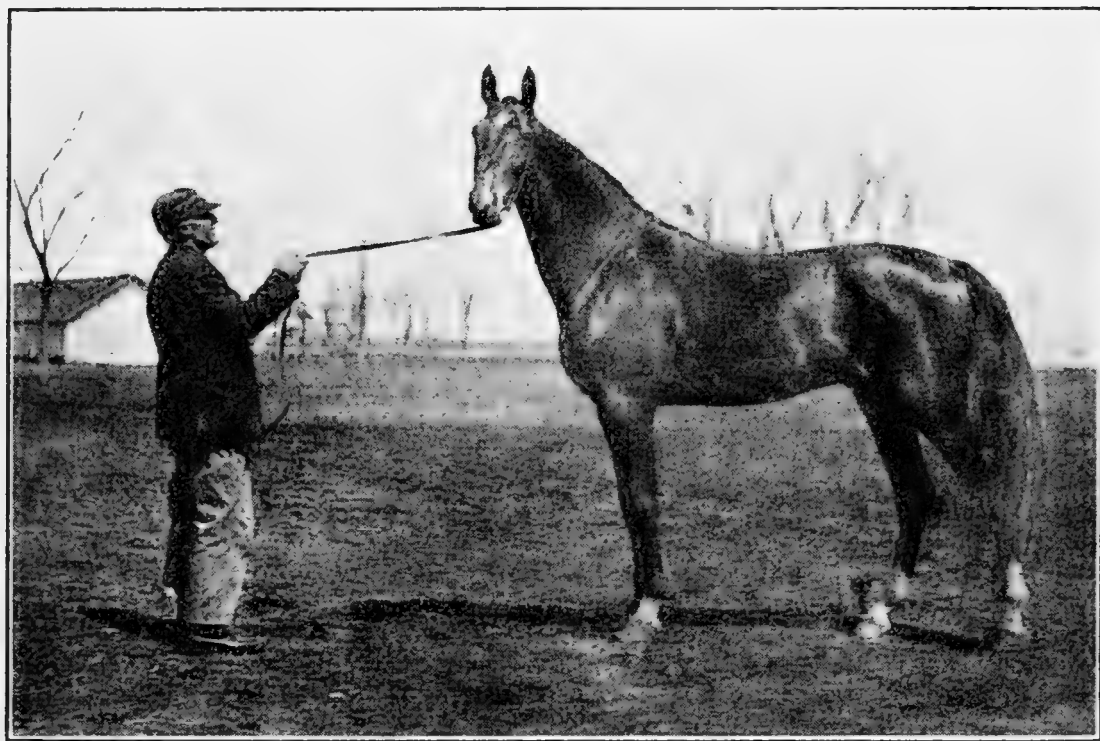
The types of horses generally recognized are classified as:—

draft
coach

roadster
speed

saddle
ponies

256. Speed Horses.— The Arabians, the Thoroughbred, and the families of the American Trotter are the



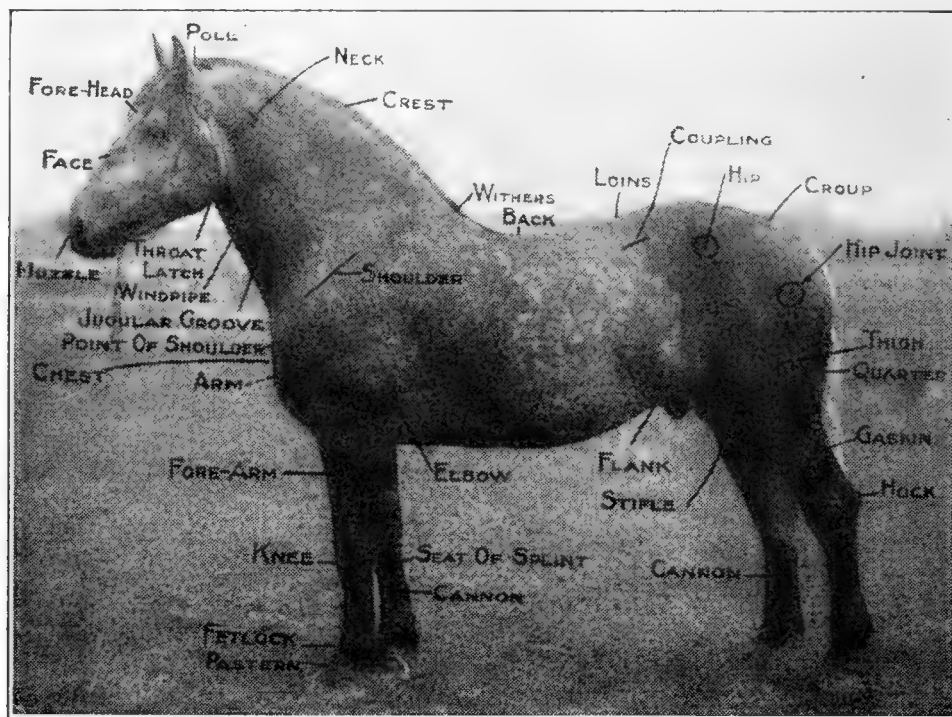
AMERICAN THOROUGHBRED TROTTER, "MAJOR KLENERT," NO. 42450

Three years old; 16 hands high; record, 2.29 $\frac{1}{4}$. Owned by Klenert Brothers, Portage, Wis.

horses noted chiefly for speed. Thoroughbred is the name given to a distinct breed of English horses which have been bred for racing for many generations. The father of nearly all American families of trotters was "Imported Messenger," brought to this country from

England in 1788. He was a Thoroughbred. Hambletonian, one of the most famous of American trotting sires, is descended from "Imported Messenger" and was foaled in 1829. Mambrino Chief, foaled in 1844, a great-grandson of "Imported Messenger," was the ancestor of many Blue Grass trotters. He was bred and developed in Kentucky.

Characteristics of Speed Horses.—In general all the horses in the different breeds of speed horses, are tall, have rather long, delicate legs, small hoofs, long narrow bodies, and are therefore built for speed.



A GOOD PERCHERON.—*Wisconsin Circular 17.*

257. Draft Horses.—The draft horses differ from the trotters and runners much as the beef breeds of cattle differ from the dairy breeds. Since draft horses are bred to pull heavy loads, and not to run races, naturally their form must be different from that of speed horses. Draft horses have a shorter and a more massive

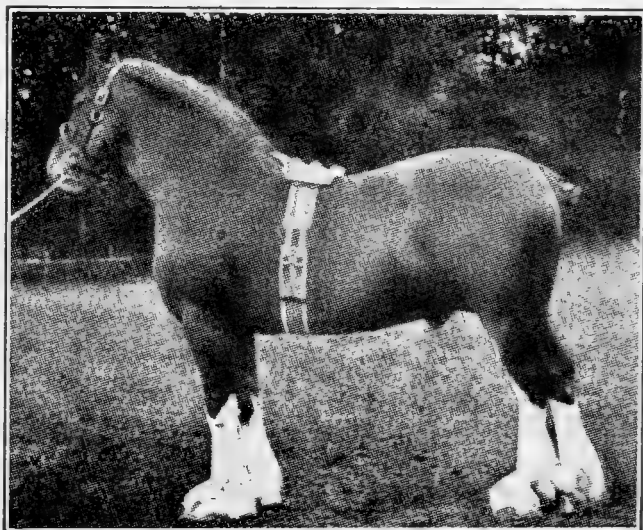
body. Their legs are short and stout, and their hoofs are large. They are characterized by great weight and rather slow movements. Among the more important breeds of draft horses are the

Percheron
English Shire

Clydesdale
Belgian

The Percheron.— The Percherons are the most popular draft horses in America. The original stock was imported from France where it has been developed for many years. The common colors are gray and black and the horses commonly weigh from 1600 to 1800 pounds. They have a comparatively small head, a massive and low set body, and they are snappy and have a good action and style.

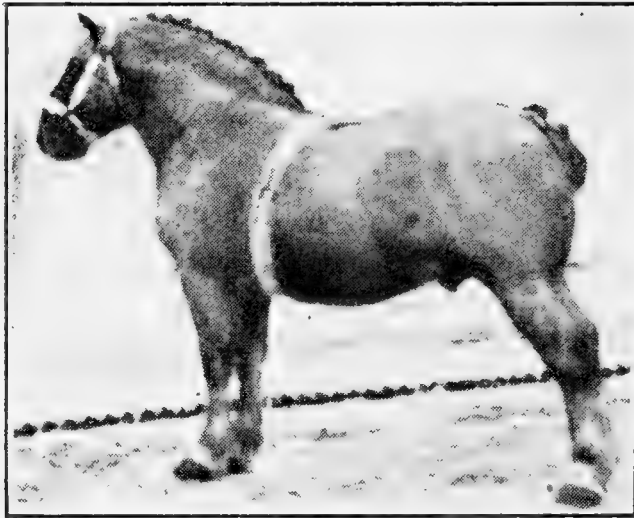
The English Shire.— The English Shire horse, sometimes merely called Shire, is one of the heaviest breeds, weighing from 1800 to 2400 pounds. The breed originated in England and is fairly well distributed throughout the United States. It may be of almost any color, although black, bay, and brown are the most common. It usually has a white spot on the forehead and as a rule has one or more white feet. The horses of the breed have long heavy hairs on the fetlock



A CLYDESDALE.— Courtesy of the American Clydesdale Breeders' Association.

called feather. In form they resemble the Percherons; they are, however, more powerful, but they are lacking in action and style.

The Clydesdale.—The color markings of the Clydesdale greatly resemble those of the English Shire. They have a white face, and usually four white legs with considerable feather. Clydesdales weigh from 1600 to 2000 pounds and are, therefore, lighter than English Shires. In color they are commonly bay, or roan. Clydesdales have a slightly longer body than do the other breeds of draft horses and are generally faster walkers. Clydesdales originated in Scotland.



A GOOD BELGIAN. DUKE OF ELMWOOD, WINNER FOUR CHAMPIONSHIPS, 1917.—*Courtesy of H. Lefebure & Sons, Fairfax, Iowa.*

The Belgian.—The Belgian is perhaps the blockiest of all the breeds of draft horses. As the name implies, the breed originated in Belgium. The horses have a short, massive, thick set body, and weigh from 1700 to 2400 pounds. The common colors are brown, chestnut, black, and they have no white markings or feathers on the legs.

258. Coach Horses.—Coach horses combine the activity of the trotter with something of the strength of draft horses. Among this class of horses may be mentioned the French coach horse, the German coach, and

the Hackney. Automobiles are greatly lessening their popularity.

259. Ponies.— Shetland ponies are the well-known sturdy beasts that, in this country, are used chiefly for children's pets. They endure almost any amount of hard usage and will do a great amount of work for their little masters and mistresses. In England they are much used in coal mines. Their native home is the Shetland Islands, north of Scotland.

Welsh ponies are growing in popularity in America; and many are being imported, and some bred here. They also are children's pets.

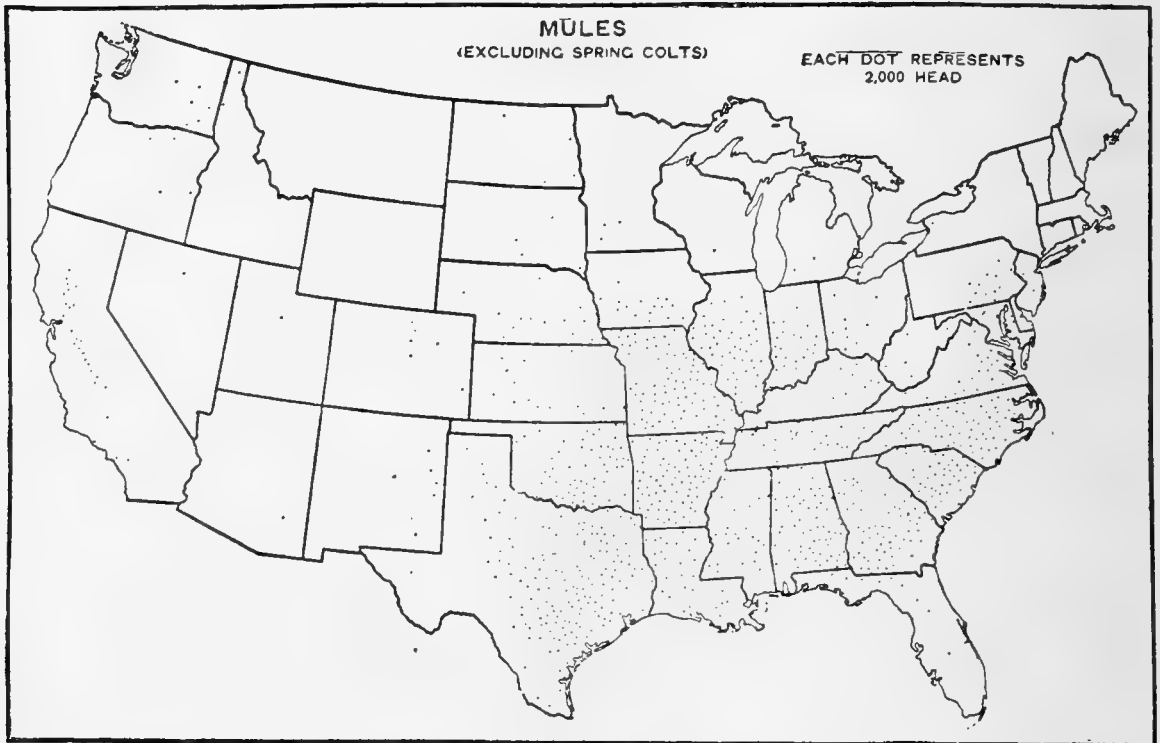
In the United States there are two common breeds of ponies, the Broncho, and the Northern Indian pony, both of which have descended from horses that escaped from the early Spanish explorers. They are the saddle horses of the Western cowboys and are good cavalry horses. They have great endurance.

Learn the different breeds of horses in your locality. Somebody knows and will gladly tell you.

260. Care of Horses.— Although horses appear to be strong and hardy, yet they are very easily lamed or made ill. They should be fed as regularly as possible, and should not be overfed, nor should the feed be changed suddenly. The horse has a small stomach, and therefore its feed should not be too bulky. Changing from old hay to new hay or grass is likely to cause indigestion, an ill which frequently becomes very serious.

Overfeeding a horse that has been kept on short rations has the same effect. New oats and corn should be

fed with caution. Dusty hay is to be avoided, certainly unless sprinkled. When a horse is heated it should not be fed grain; it is safer and better to let the horse stand half an hour before feeding it. A little hay may be given, but some careful owners will not give even hay to a warm horse. Care should be exercised also not to give a heated horse too much cold water.



DISTRIBUTION OF MULES.—*Yearbook, Department of Agriculture.*

261. Rations for Work Horses.—The standard feeds for horses are oats, corn, bran, and timothy hay. How much of these to feed a horse depends upon the size or weight, and the amount of work the horse is doing. Naturally, the harder the horse works, the more food it should have. When the horse is idle, little more than a maintenance ration should be fed. The feeding standard, Table 6, Appendix, aids in the economical feeding of horses.

Formulate rations for farm horses using the general guide given above. Compare your rations with some being fed to horses. Use the Wolff-Lehman feeding standards, Table 6 in Appendix, and balance a ration for a horse.

262. Care of Colts.— The foal should be kept with its dam in a clean and dry box stall the first three days. During the next week or two the dam and the colt should be given light exercise in a pasture or lot. When the colt is about three weeks old, it may be turned out on pasture with the dam if the weather is pleasant.

When the colt is about six weeks old, it may be fed a little oats and wheat bran, and when about two months old, it should begin to eat a little hay.

After the mare has begun to be worked again, the colt is much better off in the barn than it is following the dam about. If, on the days the dam is worked, the colt is given a little feed, and the mare is brought in to nurse the colt two or three times during the day, the young animal should thrive well.

At the age of from 5 to 6 months the colt should be weaned. Since the greatest and cheapest gains in growth of all animals can be made when they are young, it is economy to feed all young animals liberally. The colt should therefore be well fed even though it is on pasture. When one year old, a colt should be given about 3 pounds of oats, or an equivalent amount of grains per day. During the second year it should be getting from 4 to 5 pounds, and when three years old, about 8 pounds should be fed.

Good blue grass pasture is excellent for raising colts, as the grass is almost a balanced ration in itself. Bet-

ter growth, however, is always made when additional grain is fed to the growing animal.

QUESTIONS AND PROBLEMS

1. What breed of horses predominate in your neighborhood?
2. Why is it difficult to tell to what breed our common farm horses belong?
3. Give some reasons why a tractor will or will not take the place of a horse.
4. Why is it better to raise a pure bred colt than a scrub?
5. What are some rations being fed to horses in your community?
6. What does it cost to feed a horse a year?
7. What is your favorite breed of horses?
8. What are growing colts being fed in your community?

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Classification of American Carriage Horses, A. I. Cir. 113,
5 cents.

Experiments on Horse Feeding, Exp. Sta. Bul. 125, 5 cents.

Regeneration of the Morgan Horse, A. I. Cir. 163, 5 cents.

Farmers' Bulletins

Breaking and Training Colts, F. B. 667.

Breeds of Draft Horses, F. B. 619.

Principles of Horse Feeding, F. B. 170.

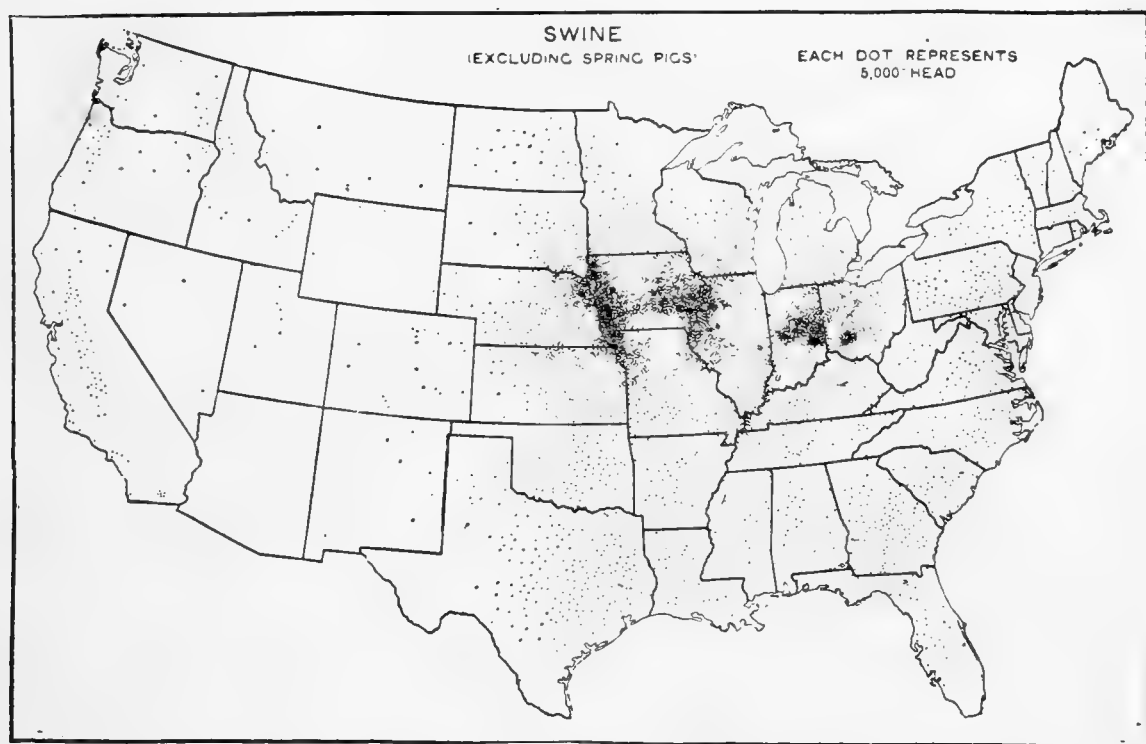
Horseshoeing, F. B. 179.

How to Select a Sound Horse, F. B. 779.

CHAPTER XXVI

SWINE AND SHEEP

Iowa, Illinois, Nebraska, Missouri, Indiana, Ohio and Kansas are our leading swine producing states. These states raise annually about 33,000,000 swine or almost 50 per cent. of all the swine raised in the United States.



DISTRIBUTION OF SWINE.—*Yearbook, Department of Agriculture.*

263. Advantages of Raising Swine.—Swine will change corn and other feed into eatable meat in less time, and at less expense than perhaps any other farm animal. Much of this time they require very little

care. They consume much waste material, and are a good side line on any farm. Usually a farmer can find no better market for his corn than his swine.

There is a close relationship between the amount of swine raised and the production of corn in the different states. The states growing the most corn also raise the most swine. We often hear mentioned the "Swine Belt States," and these states also form the corn belt.



POLAND-CHINA

264. Types and Breeds of Swine.— Swine are commonly classified into two types, the lard swine and the bacon swine. As in the case of every other animal we have studied, each type of swine is composed of several well known breeds.

265. The Lard Breeds.— The lard type of swine greatly exceeds the bacon type in numbers in the United States, because the former are much better adapted to the corn belt states where most of the hogs are raised. The lard hogs are broader, deeper, and more compact

than the bacon hogs. They fatten more readily than do the bacon hogs, and corn is better adapted to them as a feed.

The leading breeds of lard swine are:

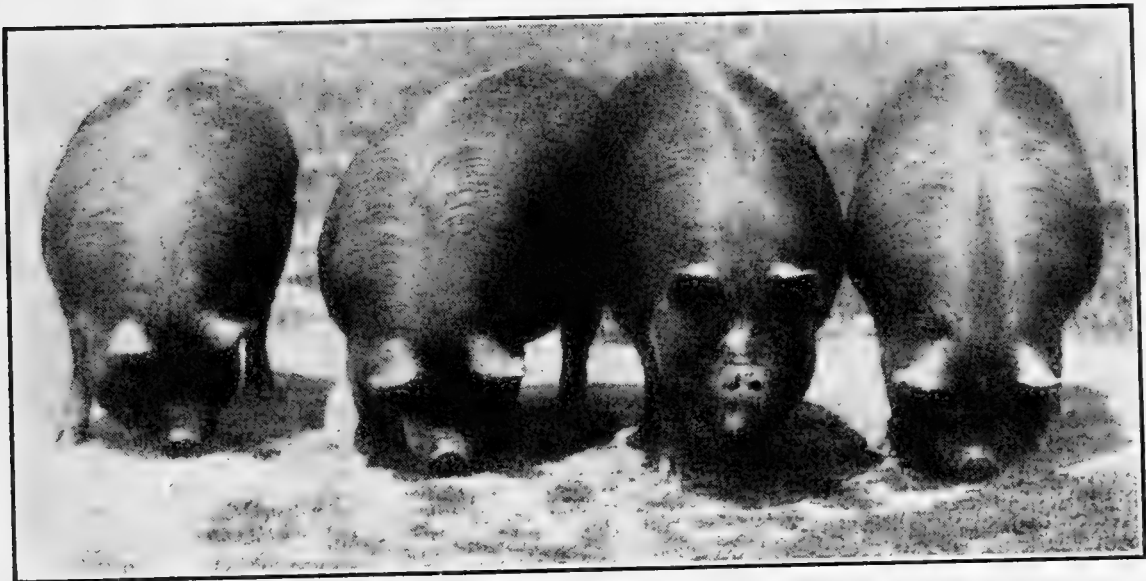
Poland China
Berkshire

Duroc Jersey
Chester White

Hampshire

Some authorities, however, include the Hampshire swine with the bacon type.

Poland China.— One of the most popular breeds is



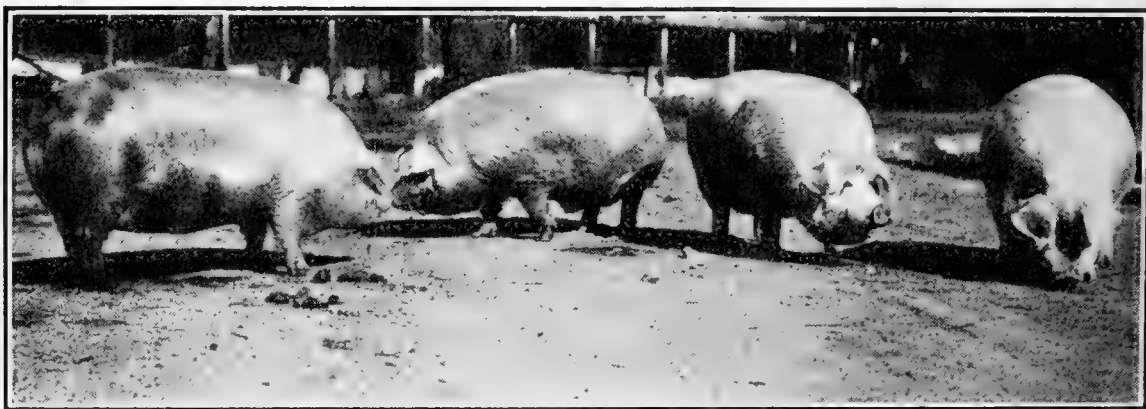
BERKSHIRES

the Poland China which originated in Ohio. The color is black and white, the white being confined in good specimens to the four feet, the tip of the tail and the nose. They have drooping ears and a comparatively straight face. They are strictly a lard hog and it is not unusual for one to weigh two hundred and thirty pounds at six months of age.

Berkshire.— In color the Berkshire swine resemble the Poland China, being black and having the same

six white points. This breed originated in England. They differ from the Poland China in that they have erect ears, and a short dished face. The body is not quite as wide nor as deep as that of the Poland China.

Duroc Jersey.— In some parts of the United States the Duroc Jersey is a popular hog, and it is becoming more popular. The color varies from a reddish yellow to red, cherry red being the standard color. In form the Duroc Jerseys resemble the Poland China, and they also have drooping ears. The Duroc Jersey breed is very



CHESTER WHITES

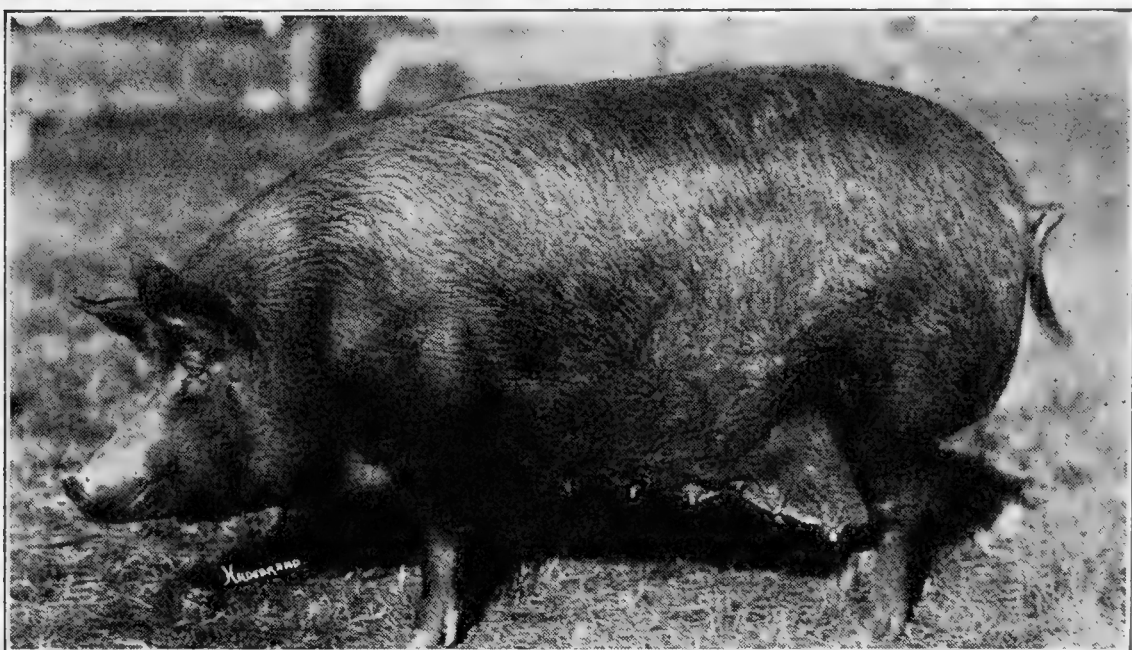
hardy and prolific; the sows make good mothers, and have good dispositions.

Chester White.— The Chester White, as the name indicates, is white in color. They are slightly larger than any other breed of lard hogs. They have drooping ears, and straight faces and their body form greatly resembles that of the Poland China.

Hampshire.— The Hampshire is sometimes called the Thin Rind hog. This breed is easily distinguished from the other breeds of swine by a characteristic white belt around the fore part of the body. The fore legs also are white, while the remainder of the body is black. They

have straight faces and erect ears. Their bodies are not as large nor as deep and broad as those of the other lard hogs, and they, therefore weigh less.

266. The Bacon Breeds.— There are two common breeds of swine that may be termed purely bacon hogs. They are the Tamworth and the Large Yorkshire. The Tamworth is gaining a slight popularity in the United States, but this popularity is outside of the corn belt



TAMWORTH SOW, GLEN LETTIE

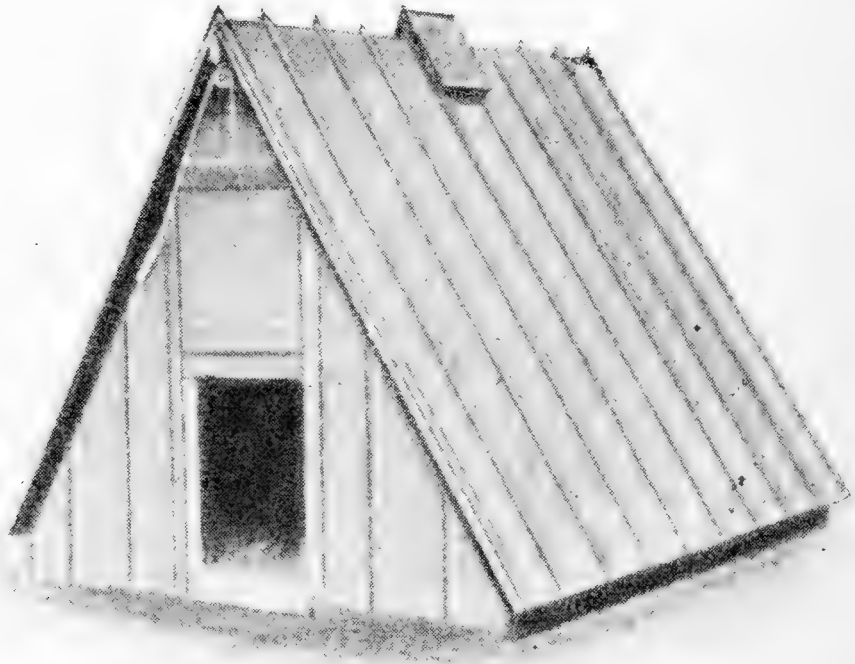
Weight at 3 years, 1,020 pounds.— *Courtesy of Jas. Mackay & Son, Far-ragut, Iowa.*

states. The bodies of the bacon hogs are not as deep nor as broad as those of the lard hogs, and they have considerably longer legs. They do not fatten as readily as the lard hogs, and they are raised primarily for bacon.

Tamworth.— The Tamworth originated in England. It has a red color, a long face, and large erect ears. It gives an excellent quality of bacon, but the hams are small when compared with those of the lard hogs.

Large Yorkshires.— The breed known as Large Yorkshires also originated in England, where it is more popular than the Tamworth. The hogs of this breed are white, have erect ears and dished faces. They are very large hogs but their bodies lack both breadth and depth.

267. Care and Management of Swine.— The hog has been called the mortgage-lifter, and such it is in the great corn belt extending from Ohio to Kansas. The



PORTABLE SWINE HOUSE.— *Courtesy of the Northern Hemlock and Hardwood Manufacturers' Association, Oshkosh, Wis.*

profit, however, depends on the supply of cheaply grown corn, and upon the ability of the hog to get considerable feed by grazing. Where the latter condition is wanting, the profit is uncertain. There should be good grazing ground, clean water, and shade. The source of the drinking water supply should not be a filthy, wallowing place. The breeding sows should be kept apart from

the fattening herd. A few weeks before farrowing time the brood sows should be put in individual pens, or into small houses having separate yards or runs. These pens should face the south; they should be kept clean, and they should contain a good, clean, dry quality of bedding. Around the pen of the young pigs planks should extend out from the wall about 8 inches and raised six to eight inches from the floor to afford a protection for the pigs from their mother. The little pigs will soon learn to creep under these planks when the sow lies down.

268. Feeding Growing Swine.—Many keepers of hogs raise a variety of forage crops, such as clover, oats and peas, rape, alfalfa, vetch and rye, cowpeas, etc. Some breeders have portable fences to control the feeding of these crops. Salt, wood ashes, and charcoal are supplied freely, and the grain feeds are fed as slops in troughs. It has been found to be much cheaper to raise hogs, weighing from two to three hundred pounds, than hogs, weighing five hundred pounds or more; the markets, also, prefer the lighter hogs. Experiments have shown that three or four pounds of good feed will add a pound to the weight of a hog under a hundred pounds, while more than five pounds of feed are required to put a pound of weight on a hog weighing over three hundred pounds. The most money is made by fattening as rapidly as possible, because it is the young growing animal that can be fattened most cheaply. Good pigs should gain from one to one and a half pounds daily and be ready for the market when from 8 to 10 months old.

Skim milk and buttermilk are valuable feeds for growing swine, and when available they may take the place of the rich, nitrogenous concentrates, such as oil meal and tankage. One hundred pounds of skim milk are considered as valuable for feeding as a half bushel of corn.

Young, growing pigs should not be fed too much corn, as corn is low in ash and protein, both of which are absolutely essential for the formation of bone, tissue, and muscle. When pigs are about four months old, no more than $\frac{1}{3}$ of the ration should be corn. After the pigs have reached the age of three months, the amount of corn fed is gradually increased, so that at the end of the fattening period, when the pigs are eight months old, their ration contains from 60 to 95 per cent. corn. This is because corn is the best fattening feed and puts hogs into a good finished condition for the market. When growing pigs are on good pasture, the amount of grain fed to them may be considerably reduced.

Value of Milk and Tankage.—All feeding experiments with growing swine show that the largest and cheapest gains are made when the corn fed to the pigs is supplemented with a feed rich in protein and ash, such as tankage, skim milk, buttermilk, alfalfa, and oil meal.

In a recent experiment at the Indiana experiment station three lots of pigs, each pig averaging 79 pounds, were fed 70 days on three experimental rations with the results shown below:

Lot 1. Fed nothing but corn.

Average gain per pig for the 70 days was 20 pounds.

Lot 2. Fed corn and tankage.

Average gain per pig for the 70 days was 94 pounds.

Lot 3. Fed corn and buttermilk.

Average gain per pig for the 70 days was 128 pounds.

In another experiment at the same station:

Lot 1. Fed cornmeal 1 part and skim milk $1\frac{1}{2}$ parts.

Average gain per pig per day 2.02 lbs. for 60 days.

Lot 2. Fed cornmeal 15 parts and tankage 1 part.

Average gain per pig, per day 1.83 lbs. for 60 days.

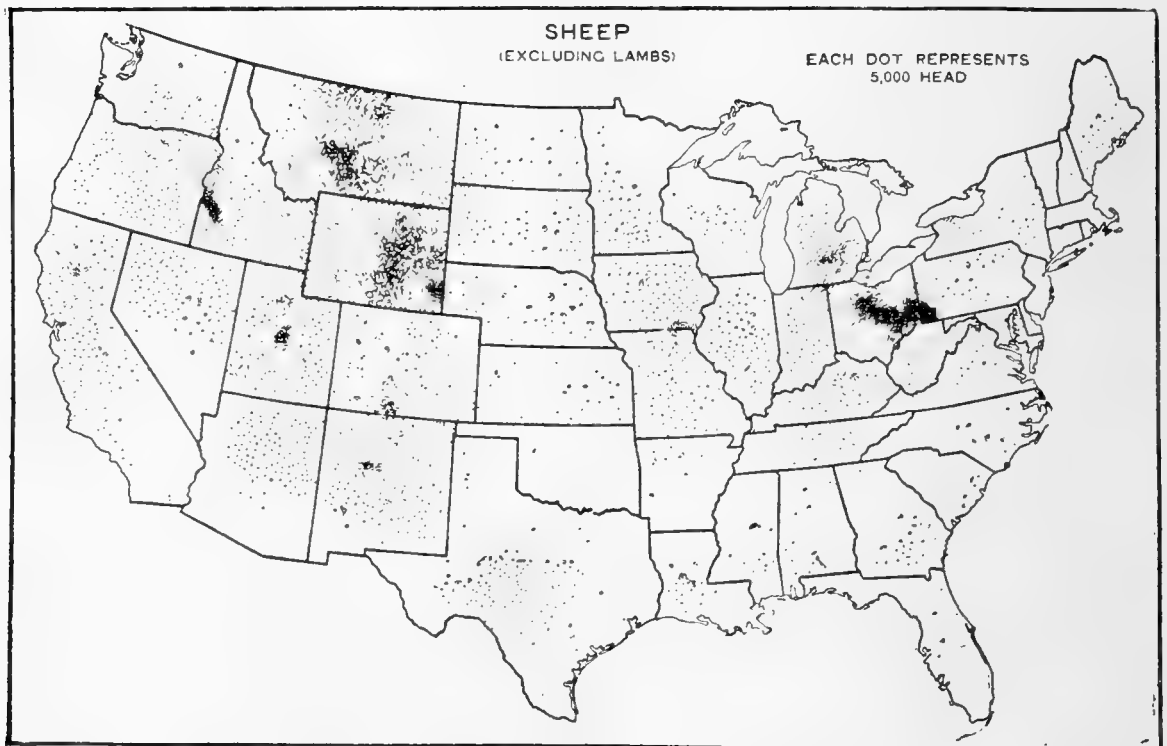
These experiments show the great value of dairy by-products and of tankage for growing pigs.

269. Fattening Swine.—The seventh to tenth months of a pig's life are commonly considered the fattening stage. During this stage the amount of corn fed, as already mentioned, is greatly increased until it forms from 75 to 95 per cent of the ration, and the amount of dairy by-products are generally reduced, until the preparation of the pigs is finished on nothing but grain and a little of some rich concentrate.

Hogging-Down Corn.—Many corn belt farmers turn the hogs, during the fattening stage, into a field of mature corn and allow them to harvest the crop. Experiments show that this is one of the cheapest ways of feeding corn to swine. In this system temporary fences are often used, so that the hogs do not cover too large an area at any one time.

270. Advantages of Raising Sheep.—On many farms sheep may be raised with much profit. The sheep yield two valuable products, wool and meat, both of which are always in demand. The amount of wool produced by a sheep for a year varies from 5 to 12 pounds

according to the breed and the size of the animals. For this wool the farmer receives, on an average, from 25 to 30 cents per pound. An average ewe will produce each year a crop of wool and a lamb. The lambs are generally fattened in the fall and shipped to the market in November or December. They can feed and be well nourished, where cattle would find insufficient food.



Yearbook, Department of Agriculture.

They also eat a great variety of feeds. More than that, sheep are economical producers of meat, requiring less feed to make gains in weight than do cattle.

Sheep are most abundantly distributed in northwestern and southwestern states. In these states, where there are still found many large sheep ranches, the sheep industry is very important.

271. Types of Sheep.—Sheep are commonly divided into three types, or classes, according to the fine-

ness and length of their wool. These types are the fine or short-wool, the medium-wool, and the long-wool. Many years ago, sheep were kept almost entirely for their wool, and then, since the fine-wool was the best, naturally the fine-wool breeds of sheep excelled.

Of recent years, however, some authorities divide sheep into two types, the fine-wool type, and the mutton type. In this classification the medium-wool breeds and the long-wool breeds form the mutton type of sheep, as these two types are raised primarily for mutton, the value of their wool being a secondary consideration. The fine-wool sheep are raised primarily for the wool they produce; with them the value of the mutton is secondary.

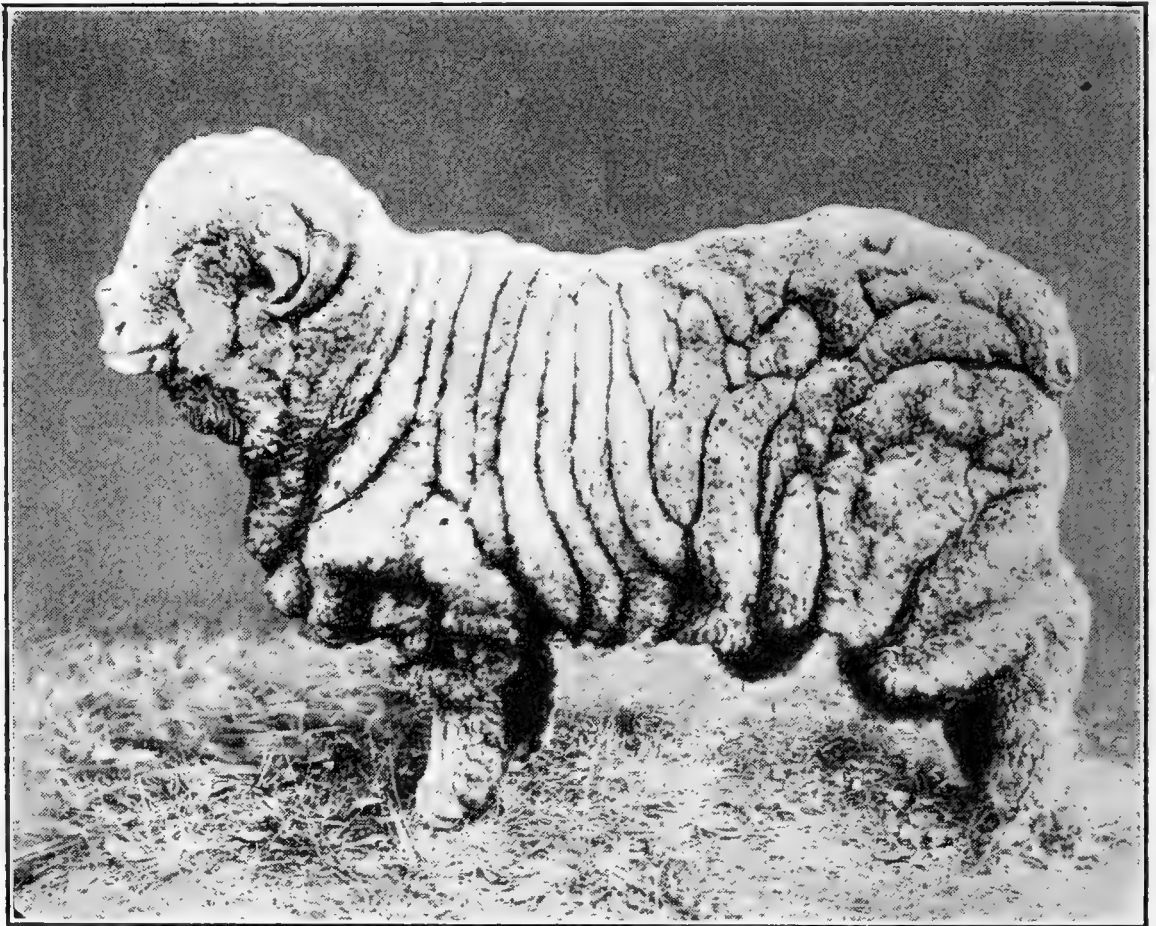
272. Fine-Wool Sheep.—The fine-wool sheep usually have more or less numerous folds on their skin. These increase the wool surface, but the folds make shearing rather difficult. The wool is very fine and heavy, averaging about 15 pounds to a clipping, and it readily forms masses. Often the oil or yolk of wool is so abundant that it causes a black, greasy mass on the surface of the animal. In form these fine-wool sheep are more or less angular, resembling in this respect the dairy type of cattle. The three breeds of fine-wool sheep are:

American Merino, Delaine Merino, Rambouillet Merino.

The Merinos originated in Spain, and it is said that the robes of Roman emperors, two thousand years ago, were made from the fine-wool of the Merinos.

American Merino.—The American Merinos have

their entire body covered with folds or wrinkles. They are the smallest sheep, but they produce more and finer wool than any other breed. The wool is about 2 inches long, and one animal yields, at one clipping, from 12 to 24 pounds. The mature ewes weigh 100 pounds and the rams 150 pounds.



A GOOD TYPE MERINO RAM LAMB

The wrinkles over all parts of the body, the density of the fleece, and the covering of the face and legs are characteristic.—*Farmers' Bulletin 576.*

Delaine Merinos.—The Delaine Merinos have fewer folds or wrinkles than the American. Their wool, also, is a little coarser and longer. The ewes and rams are both slightly larger than the American Merinos.

Rambouillet Merinos.—The Rambouillet is a French breed, derived from Merinos imported from

Spain. The Rambouillets are the largest of the fine-wool sheep, the ewes weighing about 150 pounds and the rams about 200 pounds. They produce less and slightly coarser wool than the other breeds of this class. The bodies of the Rambouillets are generally smooth, but occasionally wrinkles are found on the necks.

273. Medium-Wool-Sheep.—The medium-wool breeds of sheep form our common mutton sheep. Their wool is slightly longer and coarser than that of the fine-wool sheep, and the average shearing weighs about seven pounds. The average weight of the ewes varies from 150 to 200 pounds, and that of the rams from 200 to 300 pounds. All the breeds are hornless except the Dorset Horns. The common breeds of this class are:

Southdown	Hampshire	Cheviot
Shropshire	Dorset Horn	Suffolk
	Oxford	

All these breeds of sheep originated in England, except the Cheviot, which originated in Scotland.

This class of sheep have broad, deep, compact bodies, and never have a wrinkled skin. In form they resemble the beef breeds of cattle.

Southdowns.—The Southdowns have dark gray faces and noses and their foreheads are covered with wool. They are hornless, small, and compact, being broad, deep and smooth. They are the smallest of the *Downs* or medium-wool class. They are a highly specialized mutton breed, and in conformation resemble the Angus cattle. Though they lack size, they are good feeders and have the best wool of any breed in the medium-wool class.

Shropshires.—The Shropshire sheep have dark brown, almost black faces, noses and legs. The wool extends well down their legs, their foreheads and their cheeks, and meets below their eyes. The breed is perhaps the most popular one in America. They are good breeders and feeders, and are slightly larger than the Southdowns, which they closely resemble in form.



SOUTHDOWNS

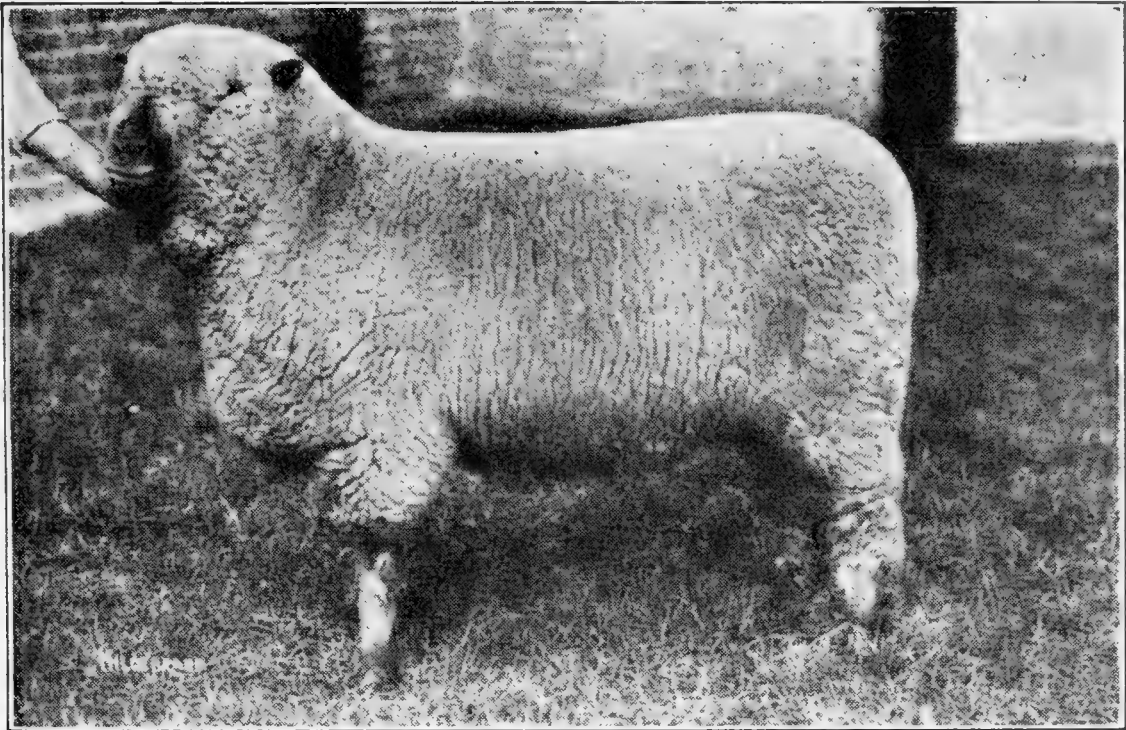
This pen of Southdown Wethers was awarded \$1,000 in prizes at the Smithfield Show.—*Courtesy of the American Southdown Breeders' Association.*

Hampshire.—The Hampshire sheep resemble the Shropshire in color, but are distinguished from them by the fact that the wool does not extend below the eyes as it does in the Shropshire. They also have longer faces, and their bodies are slightly longer and larger.

Dorset Horns.—Both the male and the female Dorset Horn sheep have horns and this characteristic readily distinguishes them from the other breeds of sheep.

They have white faces and white legs, and the wool does not extend down on their legs. They are very prolific, and are used for the production of hot-house lambs. In size they resemble the Shropshires.

Oxford.—The Oxfords are the largest of the *Down* or medium-wool breeds of sheep. Their faces and legs are brown in color, and in this respect, they resemble the



PURE-BRED SHROPSHIRE EWE.—*Courtesy of the American Shropshire Registry Association.*

Shropshire and Hampshire breeds. The wool does not extend down the face, and on the forehead it grows rather long, forming a slight topknot or tuft. Their wool is very long.

Cheviot.—Some authorities classify the Cheviot breed with the long-wool sheep. The Cheviot sheep have white faces and white legs free from wool. The wool is rather long and almost pure white. They are an active

and hardy breed of sheep and well adapted to the colder and more hilly regions, resembling Scotland, where the breed originated. In form and size they resemble the Shropshire.

Suffolk.—The Suffolk breed of sheep have long black faces, black woolless legs, and black ears. The wool extends only to the top of the head. Their body is not as deep as that of the other breeds



DORSET HORN SHEEP. Medium-wooled breed.

of this class and is slightly longer. The breed is not very popular in America.

274. Long-Wool Sheep.—The wool of the long-wool breeds of sheep is long and coarse, which makes it more open and fleecy than that of the other classes, and therefore it does not have a tendency to mat itself together. These long-wool sheep do not have the deep, low and compact bodies which the sheep of the medium-

wool class have; they have longer legs and are therefore, generally taller. The common breeds of this class are:

Leicester, Cotswold, Lincoln.

These three breeds all originated in England. All are hornless, and all have white faces, and white legs, free of wool.

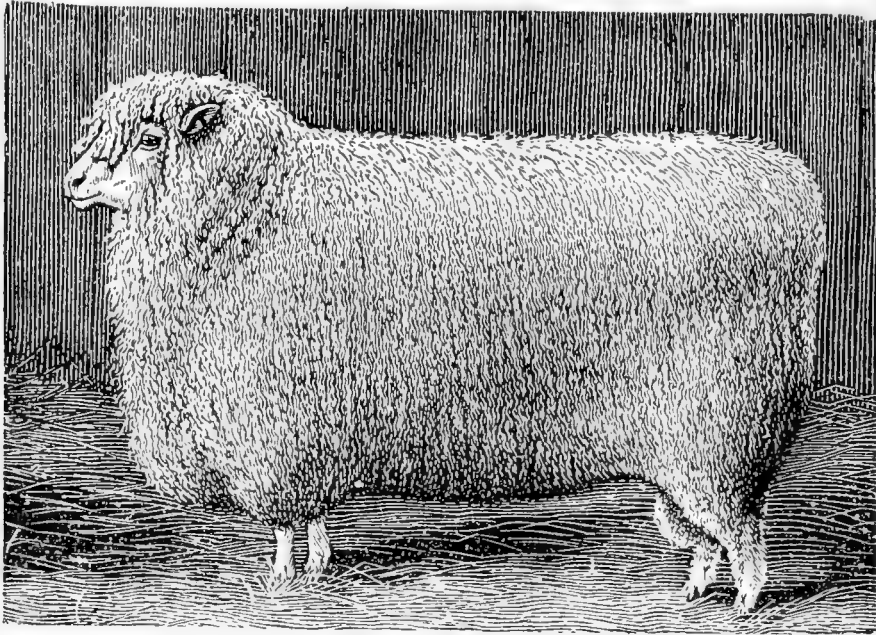


BORDER LEICESTER YEARLING EWE.—*Courtesy of the American Leicester Breeders' Association.*

Leicester.—The Leicester sheep are the smallest of the long-wool class. They can be distinguished from the Cotswold and the Lincoln sheep by the fact that no wool extends beyond the ears.

Cotswold.— The sheep of the Cotswold breed are slightly larger than the Leicester sheep, and are easily distinguished from them, and from the Lincoln sheep, by the long white curls or locks which hang over the foreheads and eyes.

Lincoln.— The Lincoln breed of sheep is the largest of any breed of sheep, the ewes often weighing 250



COTSWOLD RAM.— *Courtesy of Robert F. Hildebrand.*

pounds and the rams 300 pounds. Their wool is also the longest, averaging 12 inches, while that of the Cotswold is 10 inches, and that of the Leicesters, 8 inches. The breed can be distinguished from the Cotswold and the Leicester sheep by a short foretop.

275. Goats.— There are two common classes of goats called the Angora goat and the milk goat. In America the Angora goat is used mostly to clean up brush land for which it is well adapted. Its fleece is also a valuable product. Milk goats are raised in many European countries for the production of milk.

276. Care of Sheep.— Sheep require comparatively little care; an open shed in which they can take refuge on wet and stormy days is all that is absolutely necessary. If this is located on high ground, and some bedding is used, not even a floor is required, as the bedding, waste hay, and manure soon make a thick layer which protects the animals from dampness. The shed should be open and face the south. The hay should be fed from racks, and the grain, silage, and roots should be fed from feeding troughs.

Sheep are usually sheared in the latter part of March or in April, depending upon the climate. In general, they should not be sheared until cold weather has passed in the spring.

It is customary to dock all lambs, when they are two or three weeks old, as the woolly tail is of no use to the animal and is often a source of sickness due to the accumulation of manure, which makes a good breeding place for germs.

277. Care of Lambs.— Lambs should be weaned and separated from their mothers when they are from three and one-half to four months old. They should not be allowed to wean themselves, because this takes too long, and is too much of a drain upon the ewes.

Lambs, while nursing, will begin to eat when quite young, usually when only two to three weeks old. Commonly a “lamb creep” is provided for the lambs. This is an enclosure separated from the flock by a fence under which the lambs can creep but the mature animals cannot. In this enclosure, such feed as oats, bran, oil meal and corn meal are kept in small troughs, so that

the lambs may enter the "creep" and eat at will. This method of feeding gives them a good start and makes them ready for an early market.

278. Fattening Sheep.—The fattening period for lambs and sheep varies from 10 to 14 weeks depending upon the size and condition of the animals. Some fattening rations commonly used are:

1	2	3	4
Shelled corn	Oats	Mixed grain	Corn
Hay	Hay	Hay	Hay
Silage	Silage	Roots	

Experiments show that better and cheaper gains can be made when alfalfa or clover hay are fed, and some succulent feed such as corn silage, roots, or wet beet pulp.

Sheep will eat and thrive on most weeds and grasses growing on the average farm. They kill the weeds by keeping them cut down to the ground. Sheep make a good medium through which a surplus of forage crops and grains can be marketed with profit. There is a greater profit on a small farm by feeding this surplus of feed to sheep than there is in selling it. From the standpoint of national economy, sheep should be regarded as a farm necessity the same as poultry and swine.

QUESTIONS AND PROBLEMS

1. In the spring of 1917 hogs were selling at \$16.00 per 100 lbs. and corn was \$20.00 per ton. If 6 lbs. of corn would add 1 lb. of live weight to a hog could a farmer profitably feed corn to hogs?

2. What are the common breeds of swine in your community?

3. At \$16.00 per 100 lbs. what is the value of a herd of 80 hogs averaging 300 lbs.?

4. What are some swine rations being fed in your community?

5. What breeds of sheep have you seen in your community?

6. What are arguments in favor of certain breeds of sheep in your community?

7. What is a good ration for sheep?

8. From what and how is woolen cloth made?

9. Why are more sheep raised in Ohio than in Illinois?

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Management of Sheep on the Farm, Bul. 20, 10 cents.

Pasture System for Range Sheep Forest, Cir. 178, 5 cents.

Swine Judging for Pig-Club Members, Cir. 83, Office of Sec.,
5 cents.

Lessons on Pork Production for Rural Schools, Dept. Bul.
646, 5 cents.

Farmers' Bulletins

Pig Management, F. B. 205.

Hog Houses, F. B. 438.

Boys' Pig Clubs, F. B. 566.

Hog Cholera, F. B. 379.

Feeding Hogs in the South, F. B. 411.

Breeds of Sheep, F. B. 576.

Sheep Feeding, F. B. 49.

Raising Sheep for Mutton, F. B. 79.

Sheep Scab, F. B. 159.

Breeds of Swine, F. B. 765.

Farm Sheep Raising for Beginners, F. B. 840.

Swine Management, F. B. 874.

CHAPTER XXVII

GOOD ROADS — FORESTRY — HOME AND SCHOOL GROUNDS

279. The Farmer's Interest in Good Roads.— One of the most important things in connection with life on the farm is a good road. On the road the farmer must transport his produce to market, draw back his supplies, and travel to mill and to "meeting." Nothing contributes so surely to dislike of country and farm-life as poor roads. The farmer plodding along in the mud, his team barely able to drag the load with harness, horses, and wagon a mass of dirt, pictures to himself his more fortunate brother in the city, using paved streets and cement walks. He decides that he has had enough of farming, sells or rents the farm, and departs for the city. It is unnecessary to enlarge the picture; it is too well known. During many days or even weeks of the year, the farmer and his family are shut away from town, from church, society, and entertainment. A large part of the trouble comes from the fact that most of the work on the roads has had only a temporary effect.

280. How to Make and Keep a Road Good.— There are certain foundation principles that should govern road-making and maintenance. The man who oversees the work should have scientific knowledge of

how to make and maintain a good road. The material of the road should be graded with the coarsest at the bottom; and the successive layers should be well rolled, compacted, and filled in with finer material. The road should be well drained.

But it is most important of all to have a few work-

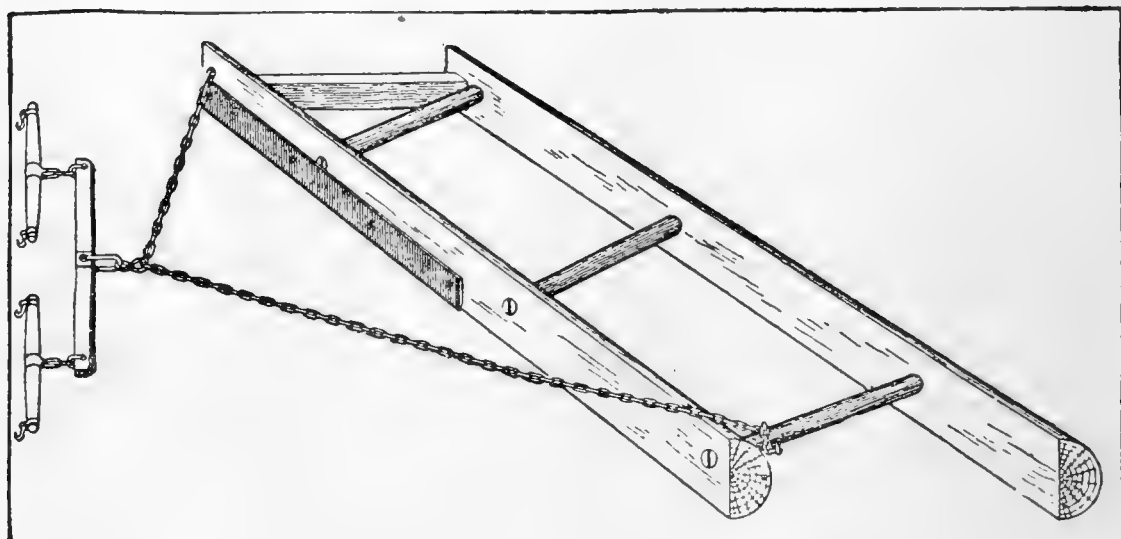


A GOOD ROAD. Typical of the best gravel road in Greene County, Iowa, which has been in use for seventeen years with no new gravel and no work upon it except road dragging in the spring. No mud has ever come through it. Graveling road of this width in this County averages \$350 per mile.—*Iowa State Department of Education.*

men constantly making repairs. The railroad companies have learned that the only way to keep their roads in good repair is to have a "section gang" with a competent boss constantly at work. Nothing made by man will last forever without attention and renewal, and a road is no exception. When a road shows signs of becoming rutty, the material should be hoed or dragged

into the ruts. A half-day's work at the right time will save several days' work later and may keep the road in good condition. The roadmaster should make it a particular point to examine the road in rainy weather. He should notice where the water collects and should fill in such places as soon as the conditions permit.

The material of which the roads are made will depend



PERSPECTIVE VIEW OF SPLIT-LOG DRAG.— *Farmers' Bulletin 321.*

on the locality and the financial condition of the abutters. Where it is possible, crushed stone should be used and a macadamized road built. In some states, the state assists and frequently builds a sample stretch of road as a model. Many miles of such roads have been built in many of the states. Where it is not possible to build stone roads, gravel may be used. There is a great difference in gravel roads, according to the kind of gravel and the plan of construction. The federal aid now available will doubtless give an impetus to a system of good trunk lines. Attention should be given to the drainage so as to avoid pools of standing water which

keep the road from drying out in spring and after rains.

281. The Purpose of Forestry.— Forestry is the art of so managing growing timber that it may be used continuously for the needs of man. It includes not only raising and care, but the handling of the grown crop, its



A FOREST PROPERLY LOGGED UNDER THE FOREST SERVICE REGULATIONS
The young growth is uninjured and the brush is piled ready for burning.

product, and waste material. When the first settlers came to this country, they found an almost unlimited amount of forest land. Four hundred years of careless cutting have so devastated our forests that, unless some heroic efforts are made, forests will soon be no more. For this reason, the subject of forestry has been receiving much attention recently.

282. Some Advantages of Forests.—It is now known that forests have an important influence on the climate. The air in a forest is some degrees warmer in winter and cooler in summer than the air in the open. The air in the forest is more nearly saturated with water than the air outside. These three conditions must affect more or less the surrounding region. The trees and the dead leaves on the ground catch the rain and hold it so that it does not run off so rapidly as it does outside, and thus floods are prevented. Equalizing the flow of streams is a most important influence of forests. As a wind break the forest is very important in some places.

283. What Other Nations are Doing in Forestry.—Almost every nation is doing something in the way of public forestry. Switzerland has one of the best systems in Europe, especially as a pattern for the United States. Forestry has been practiced there for six hundred years, and the public forests yield an annual return of about eight dollars per acre. The Swiss laws “are intended to work more through instruction, good example, and encouragement than by severe regulations.”

284. What Our Government is Doing.—There are in the United States more than 500,000,000 acres of forests. For somewhat over one hundred years the United States has made some effort to preserve the public forests. Even as far back as 1653, “the authorities of Charlestown, Mass., forbade the cutting of timber on town lands without permission.” In 1799, Congress appropriated \$200,000 for the purchase and

preservation of timber land to supply ship timber for the navy. In 1891, an act was passed which was the first step toward a true policy for the forests of the nation. This act contained a clause which authorized the President to reserve timber land on the public timber lands, covering an area of 62,000,000 acres. Their use is to protect drainage basins used for irrigating, supply grass and forage for herds of cattle, and supply wood and lumber for settlers.

285. How a Forest May Be Perpetuated.—Several methods to perpetuate a forest are in use. One method consists in dividing it into small sections and cutting one section clean each year. New trees, self-sown, will grow up; and after many years the forest will consist of areas in which the trees differ in age by one year. For example, it is found that certain trees will grow large enough for railroad ties in thirty-five years. By dividing a forest into thirty-five tracts and cutting off one tract each year, the supply could be made perpetual. Sometimes the trees for cutting are selected from the whole forest, the same ground being gone over year after year. Sometimes a strip one hundred yards wide or thereabouts is cut out and then allowed to grow up again.

Become acquainted with the trees in your vicinity and know the names of some of them.

286. Home and School Grounds.—Many school-houses and some farmhouses are situated in plots of ground that are destitute of trees and shrubs. The sun beats on the buildings in the summer and the wind

is unbroken in the winter. Nothing but barrenness is visible. If the objects that are seen daily impress our lives and help form our characters, then here is an opportunity to impress beauty rather than its opposite quality.

The work in school agriculture ought to create a



A COUNTRY SCHOOL HOUSE WITH VINES AND SHRUBS.—*Courtesy of Stark Bro's Nurseries & Orchards Co., Louisiana, Mo.*

desire in the pupils to clean up and beautify the home and school grounds. From the neglected yards the tall grass and weeds should be cut and raked into piles, the other rubbish gathered up, and all burned or removed. Grass seed should then be sown. Even if nothing further is done, most premises will repay such work by their improved appearance.

287. Trees and Shrubs.— Trees and shrubs look better, as a rule, when planted in groups or clumps, rather than scattered singly around the home or school-house. Landscape gardeners say that the larger trees and shrubs should be in the background as a setting for the buildings, with low shrubs near the buildings and open spaces with grass in front. Often trees or shrubs can be used on the boundaries in place of unsightly fences. It is a good plan to use trees or tall shrubs to hide the unsightly parts of buildings and out-houses. In selecting trees, find some that are hardy and will live readily in your locality. Some trees grow rapidly but will not live long, and usually prove unsatisfactory. The American white elm (not the red elm) and the hard maple (not the soft maple) are two standards for many localities. The basswood, or American linden, is also hardy. The blossoms are visited by honeybees, which make excellent honey from the nectar in them. The ash trees are quite satisfactory in the Northern States, as are also the sycamore, mulberry, walnut, Norway maple, horse-chestnut, and beech. If not too far north, the catalpa, tulip tree, the cucumber tree, and the sweet gum may be added to the list. If the buildings need protection from the winter winds, then evergreen trees make a good windbreak at some distance. The Norway spruce is quite satisfactory for this purpose; the Colorado blue spruce is perhaps more ornamental but not quite so vigorous in all climates. The blue spruce is often used as an ornamental tree. Directions for transplanting trees were given on page 194.

Shrubs.—In choosing shrubs, choose hardy ones. Wild shrubs that grow in the locality are often the best for the purpose. Often there is some one in the neighborhood or district who has had experience in growing shrubs in his home yard. Such a person will generally be glad to help in choosing suitable shrubs, and sometimes can supply the plants from his own yard. Do not depend entirely upon the descriptions in catalogues, or upon the advice of agents who are canvassing for shrubs and trees. Set out principally such shrubs as experience has shown will grow well in your locality.

Some of the shrubs that are used in many localities and have proved satisfactory are species of spirea, Japanese barberry, honeysuckle, weigela, lilac, snowball, double-flowering crab or plum, mock orange, sumach, dogwood, and currants. There are many different species of these shrubs, some being better adapted to one purpose and some another. If it is desired to form a hedge, the lilac, bush honeysuckle, arborvitae, elderberries, or others similar in character, will be found suitable. If there is a corner that can be filled with shrubs, tall ones should be set out in the rear and low ones in the front. The Japanese barberry is a pretty dwarf variety, and Waterer's spirea is very desirable as a low shrub, while the rose-colored weigela, tartarian honeysuckle, and mock orange are taller and suitable for places in the background. Because it encourages wheat rust, the purple barberry should be avoided.

288. Vines.—There are many climbing plants that

can be used to make a yard beautiful. This is especially true around porches, over the doors, along walls, on arbors, or to cover unsightly objects. Climbing roses, clematis, Virginia creeper, bittersweet, English ivy, Boston ivy, climbing honeysuckle, wistaria, trumpet creeper, and wild grape vine are all suitable for use. A word of caution is needed here, as well as at all points in gardening; namely, that care must be exercised in the arrangement of the plants, or the results will be unsatisfactory. Each vine has its own beauty, determined by its form, leaves and blossoms. The effect desired in any given place must determine the kind to be planted. There are a number of annual climbers that may be used in some places with good effect, such as morning-glory, wild cucumber, cinnamon vine, moon-vine and Madeira.

289. Flower Garden.— Flowers should be raised in the garden or close to the sides of the house, but not in front or in beds on the lawn. It is, as a rule, better to leave the lawn directly in front of the house clear of trees, shrubs and flowers, but at the sides and rear trees and shrubs may be arranged according to some plan, and the shrubs may be bordered with flowers.

One of the most interesting flower beds may be made from the native flowers which grow in the vicinity. If a shady corner can be found, ferns make a very satisfactory background near buildings. Violets will usually thrive if transplanted with care; bloodroot, anemones, hepatica, spring beauties, pasque flowers, columbine, and many other flowers can be added. Ferns often can be added to such a bed with good ef-

fect. This is an excellent flower bed for a school yard, as the children can dig up the specimens for the bed and tend to them as they grow. The blossoms also will appear early in the spring, before the vacation begins.

Old-fashioned flowers can be grown with satisfaction in the flower garden. Hollyhocks, phlox, dahlias, sunflowers, pinks, nasturtiums, stocks, verbenias, mignonette, larkspur, and candytuft represent a partial list from which selections may be made. These are more suitable for the flower garden at home than at school. Some of these are suitable for borders along walks where shrubs are used in the background.

Bulbs.—In place of sowing seeds as for the above-named plants, bulbs may be set out. A bulb is a short underground stem having buds and many scales, which represent leaves. Many of the early-flowering plants come from bulbs, in which much food has been stored in the scales. The crocus is the earliest of these plants to bloom out-of-doors in the spring. The hyacinths, tulips, narcissi, and lilies are very satisfactory. These bulbs should be planted in the ground in the autumn before the ground freezes. They will be ready to start with the first warm spring days. If the winters are very severe it may be best to cover the ground with leaves to protect the bulbs.

Perennials.—There are many hardy plants that may be used in clumps in place of the bedding plants. The bedding plants must be renewed every year, and it is always late before they can be started. The hardy ones live over the winter, and increase from year to year.

The investment here is a permanent one, while the other plants must be renewed each year.

Make a plan for improving the school grounds.

The most satisfactory flower gardens are those containing a good selection of perennials laid out in accordance with approved plans. There is as much opportunity for the display of good taste in this matter as in the furnishing of the inside of the house. Landscape gardening is being studied by many persons, and more and more grounds are being planned so as to produce harmonious effects with the building and its grounds.

A few good perennials for a border garden are: Peonies, Shasta daisy, gaillardia, tiger lily, phlox, coreopsis, columbine, larkspur, iris, mallow and bell flower.

QUESTIONS AND PROBLEMS

1. Describe how some good roads have been built in your community.

2. What good road making materials are there in your locality?

3. Is all limestone equally good for road making? Explain.

4. Why are roads built higher in the center than on the sides?

5. Why should ruts in roads be filled immediately with new materials?

6. About how many board feet of good lumber can be obtained from a tree which will yield two logs, 12 ft. long with an average diameter of 12 in., allowing one-fourth for waste in sawing?

7. What is the value of the lumber at \$50 per M.?

8. Name the shrubs grown on your home grounds.

9. What would be good shrubs to plant around the borders of your school yard?

10. Make a drawing showing where flowers and shrubs could be well placed on your school grounds.

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Tree Planting by Farmers, Year Book, Sep., 566, 5 cents.

Progress in Saving Forest Waste, Year Book, Sep., 534, 5 cents.

Management of Second Growth Sprout Forests, Year Book, Sep., 525, 5 cents.

Fire Prevention in National Forests, Year Book, Sep., 548, 5 cents.

The Design of Public Roads, Yearbook, Sep., 727, 5 cents.

Farmers' Bulletins.

Beautifying the Home Grounds, F. B. 185.

Forestry in Nature Study, F. B. 468.

Primer of Forestry, Part I, F. B. 173.

Primer of Forestry, Part II, F. B. 358.

Forest Planting and Farm Management, F. B. 228.

Modern Conveniences on the Farm, F. B. 321.

Benefits of Improved Roads, F. B. 311.

Sand-Clay Roads, F. B. 338.

Insect Enemies of Shade Trees, F. B. 99.

Tree Planting on Rural School Grounds, F. B. 134.

The Lawn, F. B. 248.

Care and Improvement of the Wood Lot, F. B. 711.

Roses for the Home, F. B. 750.

The Windbreak as a Farm Asset, F. B. 788.

CHAPTER XXVIII

SCHOOL-HOME PROJECTS

AGRICULTURAL CLUBS

290. Importance of School-Home Projects.— If the study of agriculture is going to mean much to a pupil, it must consist of more than recitations from a text book, and of laboratory exercises and field trips. To be sure the laboratory work and the field trips are important, and greatly help to convey clear ideas, but unless one puts into practice some of the principles of agriculture by actually doing something, that is, by carrying on some agricultural project, what he has learned will soon be forgotten, and the most vital phase of the study of agriculture will have been neglected.

291. Some Schools Require Project Work.— In some states, and in many counties of other states, each student that wishes to enter a class in agriculture, must carry on some school-home project. In many schools, no credit even is given for the study of agriculture unless a student has satisfactorily completed a project.

292. Nature of School-Home Projects.— Any agricultural work, which is done at home, but which at the same time is done as a part of the instruction in agriculture of the school, may be called a school-home project, a home-project, or merely a project.

The nature of the different projects, which may be carried on by pupils, varies greatly, depending upon the pupils, upon market demands, and upon the types of farming being done on the home farms of the pupils. Some of the commonest projects are vegetable growing, the care and feeding of animals, the growing of corn,



PROJECT WORKERS.—*Farmers' Bulletin 813, Department of Agriculture.*

the managing of poultry, and the raising of animals. A list of home projects is given on page 327.

293. How a Pupil May Start a Project.—Any pupil who wishes to start a well planned home project, and to do the work in a business-like manner, should talk the matter over with his teacher and with his parents, and come to a definite conclusion as to what his project is to be. A well conducted school-home project is really an informal business arrangement between a pupil, his parents, and his teacher. The pupil agrees to do some particular kind of work; the parents agree to see that

this work is regularly attended to; and the teacher holds the pupil responsible for that part of the work which may be concerned with the school work, such as the keeping of accounts; the carrying on of some outside reading in reference to the work; the writing and expressing of his ideas concerning it. The teacher also demands frequent reports, written or oral, regarding the progress and results of the project, and finally, requires a summary or story of the project, with a financial statement, if money is involved in the project.

Generally, also, the work of the project itself is at least partly supervised by the teacher, by a special instructor in charge of project work, or by a county agricultural agent.

294. Some Results of Project Work.—Because so many factors enter into the work, the results obtained by pupils in their project work naturally vary. It is safe to say, however, that if a project is well planned and conducted, if the directions and suggestions given by the teacher and obtained from assigned readings, are carefully followed, and if the weather is favorable, the results will be very good.

A recent Agricultural Year Book gives some interesting examples of project work with pigs. A few of these are here stated:

A boy in Massachusetts fed two pigs, which, during the last 92 days of the feeding period, made a total gain of 421 pounds, or an average daily gain of 2.28 pounds per pig.

Another young boy raised a pig, fed it, and took entire care of it, and when this pig was eleven months old it weighed 450 pounds.

A young boy exhibited a sow and her litter of nine pigs at

the Louisiana State Fair in 1915 for which he was offered \$400. This offer he refused but he did sell four of the pigs for \$260. He kept the sow and the other five pigs, which he valued at \$600. He figured that his net profits with these pigs for his year's work amounted to \$647.12.

Surely these boys, as well as thousands of others, engaged in pig projects, mastered the subject of feeding swine. Could they have done this if they had not undertaken their projects?

A young Wisconsin boy bought three high grade beef steers in March. He fed these steers and did all the work in caring for them. In the fall he exhibited the steers at three different Fairs and the cash premiums which he won amounted to \$688.

In Cook County, Illinois, a 12 year old boy made a net profit of \$138.26 by growing onions on a piece of ground measuring 100 square rds.

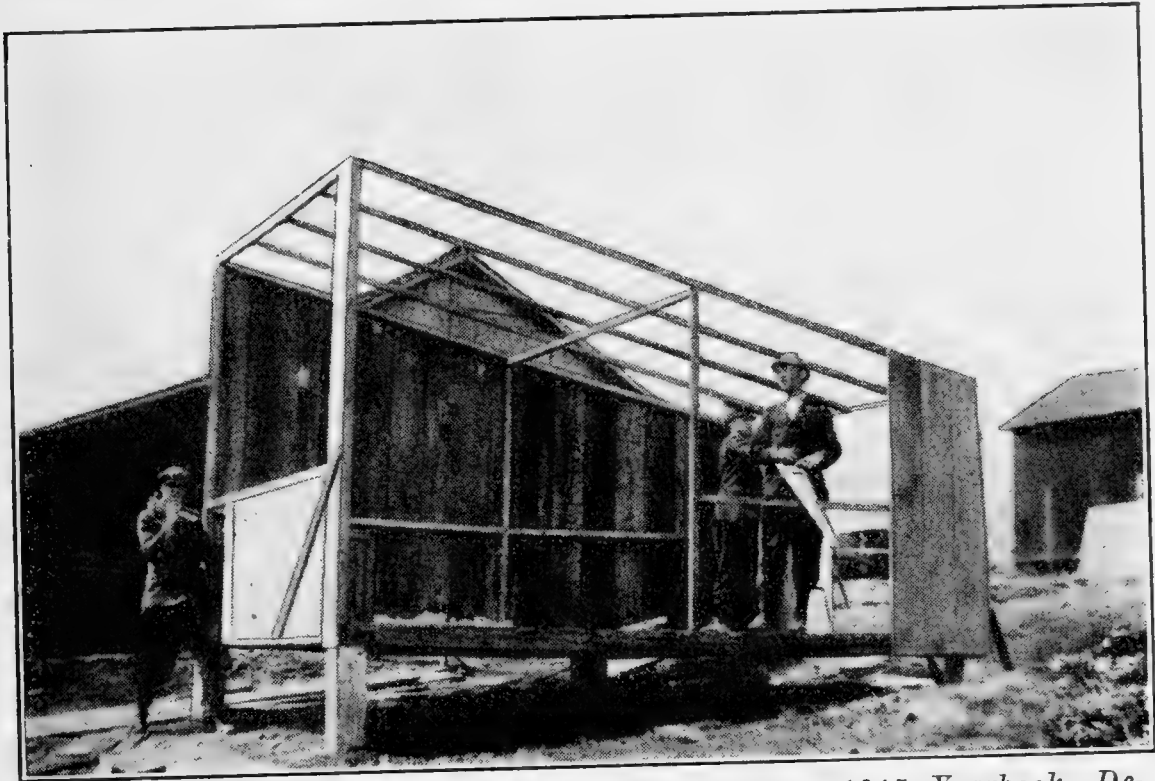
Another 12 year old boy made a net profit of \$134.35 from 80 square rods planted to tomatoes.

These facts merely give a slight idea of some of the results actually accomplished. In every state there are hundreds of boys and girls making large profits from their projects. Some of the largest yields of corn ever obtained have been made by boys in corn-club work. All these instances cited show that when one does work the way it should be done, the results invariably are good.

It should be the ambition of every pupil living in the country to undertake every year while attending school some home project in connection with the school work in agriculture. He should succeed with these projects much better than he would have done had he

not studied agriculture. He should secure a good financial gain from his project, and more important still, he should acquire a training from the work which will be a valuable asset to him throughout his life.

295. Kinds of Projects.—The kinds of projects undertaken should be adapted to the ages of the pupils. Each pupil should always select, or be assigned, a work



POULTRY-CLUB BOYS BUILDING A POULTRY HOUSE.—1915 Yearbook, Department of Agriculture.

along some line in which he is especially interested. A pupil's first project should be a simple one, and not of too long duration.

Examples of Simple or Short Projects

1. Managing a small part of the garden.
2. Feeding chickens and gathering the eggs.
3. Weekly testing of the milk of one or more cows.
4. Testing the seed corn to be used.

5. Monthly milk record of one or more cows.
6. Growing a few kinds of flowers.
7. Feeding a calf, colt, or a litter of pigs.

Examples of Longer Projects

1. Raising vegetables for the market.
2. Growing and canning tomatoes.
3. Managing the poultry flock.
4. Growing a crop of corn, potatoes, etc.



WILLARD MARTIE, DISTRICT 138, DIVISION FOUR

Started in the Poultry Project with a trio of geese March 1, 1916. He made \$19.50 from his project.—*Courtesy of Miss Catherine McLaughry, School and Country Life Director, Cook Co., Ill.*

296. Planning a Project.—The pupil should discuss with the teacher the general plan of the selected project and the method of conducting it. Often it is possible to get the State Leader of Boys' and Girls'

Club Work of the State College of Agriculture to talk to the pupils and to give them a general idea of what should be done and how to go about it. Often the County Agricultural agent or the County Superintendent of schools will explain the work.

First, an outline of the project should be made, indicating:

1. The reading which should be done to gain information necessary for the successful conduction of the project, if its nature requires this.
2. The work which must be done.
3. The things that should be observed as the project progresses.
4. What facts in regard to the project should be recorded.

The plan or outline of the project should then be neatly and carefully written and kept for a guide in the work.

297. Suggestive Outlines for Projects.—Below are given several suggestive outlines for the conduction of school-home projects which may help in planning one.

Project 1.

To find out how much butter-fat is produced during a month by each cow in the herd.

A. Assigned Reading.

References to books and bulletins.

B. Preliminary Study.

1. How is the milk of each cow weighed?
2. How are the weights recorded?

3. How often are samples of milk to be tested to be obtained, and how are they to be kept?

4. What are the steps in testing milk?

5. How is the amount of butter fat calculated?

C. Work and Observation.

1. Weighing and recording weight of milk of each cow.

2. Obtaining and keeping accurate samples of milk.

3. Testing the milk, and recording the tests.

4. Calculating amount of butter fat produced.

D. Discussion of Results.

1. Are the results good or poor?

2. How do you account for the yield of the cows?

3. How do the results vary? Account for this.

Project 2.

Managing a flock of laying hens.

A. Assigned Reading.

References to books and bulletins.

B. Preliminary Study.

1. What are the essentials of good poultry houses?

2. How should poultry be housed during winter?

3. What would be the best and most economical rations to feed?

4. How and when should the flock be fed?
5. How are the good birds selected?
6. What records should be kept and how?

C. Work and Observation.

1. See that the poultry house is comfortable and convenient.
2. Weed out the flock and keep only the best birds.
3. Feed and water the birds regularly.
4. Gather and properly store and market the eggs.
5. Keep the house clean and free of pests.
6. Keep accurate accounts.

D. Discussion of Results.

1. Success of the project.
2. Difficulties encountered.
3. Knowledge gained.
4. Profits.

298. Final Report of a Project.—When the project is completed, the pupil should make a brief, written report giving the most essential feature of the project, and, where one can be made, a financial statement. Often, however, a project does not involve any money. In some schools each pupil enrolled in project work is given a blank record book of 12 to 14 pages, in which are (1) a place in which to insert the picture of the project worker, (2) a summary sheet on which to record the name of the pupil, his age, the teacher's name, the nature of his project, the size of his plot, the crops he raises, etc., the total income, the total cost,

the total profit, and the disposal of net proceeds, (3) several sheets ruled as a cash book, intended for the enumeration of receipts and expenditures, (4) five or six pages to contain the story of the project, (5) a page on which to record the names and dates of visitors, and (6) a page on which to record the articles read and studied in the work of the project.

When final reports, similar to these, are made, the records should be systematized and recorded in good, business-like manner. Usually, however, in place of the use of blank record books, pupils make illustrated booklets, for the summary of a project. When these are carefully made they reflect much credit on the pupils.

299. The Story of a Project.— In writing the story of a project the diary form, giving the dates of the progress of the work, is most commonly used. The story should include:

1. How and from whom the land was obtained, if land was used.
2. Date the project was started.
3. Dates of different operations.
4. Progress and important incidents.
5. Disposal of proceeds.
6. Disposal of crops.
7. Reasons for success.

Naturally the story will vary according to the nature of the project, and according to the pupil. The outline here given is merely for suggestive purposes.

300. Results of School-Home Projects.— If the project was carefully planned and conducted properly,

the pupil will have succeeded in the work. He will have gained by it far more than he himself realizes, for he will have acquired the practical information that comes from the accomplishment of some real practical work. He will also have learned how to keep records and accounts in a business-like manner.

In one school district in Illinois, in one season, the average net profits of 29 pupils enrolled in school-home projects was \$40.86. The ages of these pupils varied from 10 to 14 years. Each pupil made a booklet. The making of the booklet developed careful planning, neat writing, accurate spelling, and clear expression of thought. These booklets were not only a source of pleasure to the pupils but something they had a right to be proud of. The project work also afforded excellent reading material, gave many topics for oral and written language work, and suggested many practical problems in arithmetic.

301. Boys' and Girls' Club Work.—Whenever a number of pupils of a school engage in projects, a school-home project club should be formed. Most states now have located at their State Agricultural College, a department which has charge of the club work within the states. The leader or director of this work is supplied with much material, such as outlines of projects, suggested constitutions and by-laws, and many other suggestions concerning the organizing and conducting of boys' and girls' agricultural clubs. The United States Department of Agriculture, as well as the individual states, also maintains such a department. Any information desired may be obtained from either source.

Often, if he is asked, the State Leader will come to the school and help organize a club. Any of the projects listed on pages 327–328 may be selected for a club project. The more common club projects are:

corn clubs	calf clubs	sheep clubs
poultry clubs	tomato clubs	pig clubs
canning clubs	feeding cattle	milk testing
colt clubs	clubs	clubs

Club organization stimulates pupils, creates a wholesome rivalry, offers excellent means for comparisons, and adds much interest to the work. The value of club work cannot be overestimated and in some localities it is responsible for much of the agricultural improvement.

Steps in organizing a local boys' and girls' agricultural club are given below:

1. Write to the state leader of club work at the State Agricultural College for suggestive material and blanks.
2. Determine the nature of the projects which would be best suited to the community.
3. Talk matters over with parents before enrolling.
4. Enrolling of members and forming the club.
5. Election of officers.
6. Adoption of a constitution for the club. State club leaders have samples.
7. Secure local leadership.
8. Hold regular meetings.

QUESTIONS AND PROBLEMS

1. What home projects have you ever carried on? Give an account of them.

2. How much money have your home projects netted you?
3. Why are home projects better than experiments carried on in the school room?
4. What home projects do you think could be successfully conducted in your locality?
5. What kind of a home project would you be interested in?

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

Boys' and Girls' Corn Clubs, B. P. I. Doc. 803, 5 cents.

Results of Boys' and Girls' Club Work, B. P. I. Paper, 5 cents.

Lessons on Poultry for Rural School, Bul. 464, 10 cents.

Farmers' Bulletins.

The Home Vegetable Garden, F. B. 255.

Boys' and Girls' Agricultural Clubs, F. B. 385.

Boys' and Girls' Poultry Clubs, F. B. 562.

Farm Bookkeeping, F. B. 511.

Boys' Pig Clubs, F. B. 556.

Canning Tomatoes at Home and as Club Work, F. B. 521.

Use of Diary for Farm Accounts, F. B. 782.

CHAPTER XXIX

SCHOOL GARDENS

School gardens have passed the experimental stage and are no longer regarded as fads. They are now so well established in all sections of the United States, and have met with so much success, that they will continue to grow more and more popular.

Whether or not a school should undertake a school garden depends upon a number of factors. Large school gardens require the services of some one who not only is familiar with garden work but who can direct it successfully in all its phases, such as the selection of the site, the planning, the fertilization of the soil, the preparation of the seed bed, the staking out of the garden, the ordering of seed, the planting, and the cultivation. The school garden, if undertaken, should be continued throughout the summer and the early fall, and it should be a finished success. It is discouraging to the pupils to fail to complete something they have begun, and the school garden had better not be undertaken at all unless it can be carried through the season and made a success. The proper direction of the work, and its continuation during the summer months, when school is not in session, are the most important factors entering into successful school gardens. School garden work is usually most satis-

factorily accomplished by the employment of a special teacher who thoroughly understands this work.

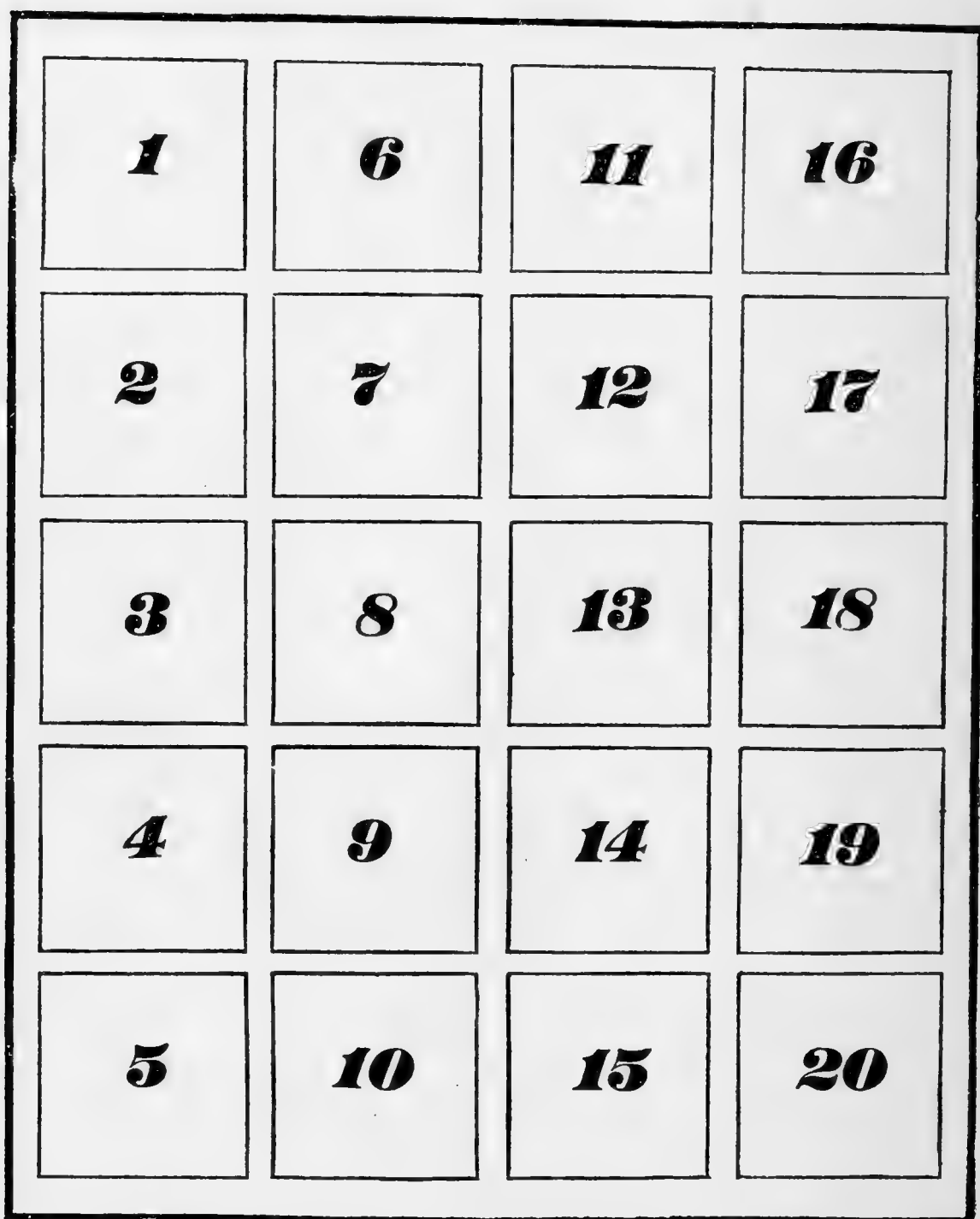
302. Conducting School Gardens.—The general principles governing the selection of the sites for school gardens, the fertilization of the soil, the preparation of the seed-bed, the planting of seeds, and the cultivation, are similar to those given in Chapter XVII for the home



SCHOOL GARDEN, EMERSON SCHOOL, GARY. Note the systematic order, close observation, etc.—*Courtesy of Frank E. Highway, Co. Supt. Lake County, Ind.*

garden. The planning should be done on paper during the winter. The choice of vegetables should be made carefully. Subjects like testing seeds, planting seeds, raising and transplanting seedlings, cultivation, and other related topics should be discussed thoroughly with the pupils before the practical work is started in the spring.

303. Planning the School Garden.— In order to make an accurate plan for a school garden it is essential



PLAN OF A SCHOOL GARDEN 70' x 87'. 20 plots each 15' x 15'

that the site be carefully measured, and that it be known just how many pupils are to have plots in the

school garden. With these two considerations, one has the basis for a good plan.

Let us assume that a field, 70 feet wide and 87 feet deep, is available, and that twenty pupils are to be accommodated. The plan suggests how this may be done.

Each plot measures 15 by 15 feet, and has a path 2 feet wide, and 2 feet at each side running lengthwise through the garden. At each end of the garden there is a path 3 feet wide. The paths running crosswise between the plots are 18 inches wide.

304. Laying Out the Garden.—In laying out this garden, stakes marking the outside corners of each plot should be carefully located, using a tape line. Then a line of stakes should be located lengthwise through the center, marking the corners of the plots. Using as guides the stakes around the outside of the garden and also those through the center, the four corner stakes for each plot may be located.

305. Planting Schemes for School Gardens.—In planting the garden the plan must be carefully followed. In some school gardens the crops planted in each plot are exactly alike and the same kind of vegetable is found in the same row of each plot, making continuous rows of the same kinds of vegetable from one end of the garden to the other.

Sometimes this scheme is varied, so that one row or series of plots such as 1, 2, 3, 4 and 5, as shown on the plan, are planted exactly alike, and the crops grown in another series or row of plots vary. This permits the student a little choice, as he may choose a plot in a series which suits him the best.

15 FT.

1'	Peas
2 1/2'	Peas followed by Tomatoes
2'	Beans
2'	Beans followed by Beets
2'	Swiss Chard
1 1/2'	Beets followed by Radish
1 1/2'	Carrots " " Lettuce
1 1/2'	Parsnips
1'	

PLANTING SCHEME 2.

1'	Corn or Potatoes followed by Radish
1 1/2'	Radishes
1 1/2'	Corn or Potatoes followed by Turnips
1 1/2'	Lettuce
1 1/2'	Spinach followed by Tomatoes
1 1/2'	Onion Sets
1 1/2'	Spinach followed by Tomatoes
2'	Peas " " Beans
2'	Peas " " Beans
1'	

PLANTING SCHEME 4.

15 FT.

1'	Parsnips
1 1/2'	Beets followed by Radish
1 1/2'	Carrots " " Spinach
1 1/2'	Radishes " " Beans
1 1/2'	Spinach " " Beans
1 1/2'	Onion Sets " " Beets
1 1/2'	Lettuce " " Carrots
2'	Beans " " Turnips
2'	Beans " " Turnips
1'	

PLANTING SCHEME 1.

1'	Radishes followed by Corn
1 1/2'	Lettuce
1 1/2'	Spinach followed by Corn
1 1/2'	Onion Sets
1 1/2'	Peas followed by Potatoes
1 1/2'	Onion Sets
1 1/2'	Peas followed by Potatoes
2'	Beans followed by Turnips
2'	Beans " " Lettuce
1'	

PLANTING SCHEME 3.

Scale 1 foot = 1/4 inch.

Often pupils may be allowed to plant whatever they wish, but a plan should be requested from each pupil, which shows the rows of his plot running in the same direction as the others in the garden, and which shows also the proper interval between the rows.

306. Ordering the Seeds.—With a definite plan in mind, it is easy to make out an economical seed order by simply adding up the number of linear feet of each kind of vegetable required and consulting a seed catalogue which shows the amounts of seeds required for given areas.

307. Vegetables to Grow.—If the rows of the garden run north and south almost any kind of vegetable may be grown. Below are given four different planting schemes, each suitable for a plot 15 feet by 15 feet. Any one of these may be used to plant either a series of plots or the plots.

Having determined the size of the plots, it is excellent work for a pupil to adjust the vegetables he wishes to grow, to the plot, allowing proper distances between the rows. There is no limit to the different kinds of planting schemes suitable for one plot, but by grouping those pupils who wish to plant the same general vegetables, it is usually not difficult to find enough pupils who are willing to use the same planting scheme, to take all the plots in a series.

The planting schemes given show both companion and succession crop. In many school gardens the planting of succession crops is left entirely to the students. Here, as in all planting, a plan is generally submitted first, and the pupil is thus guided in his work.

308. Preparation of the Seed Bed.— If the garden is large, a man with a team of horses should be engaged to plow, disk and harrow the ground. The soil should be fairly smooth, level, and in a good crumbly condition, when he has finished his work.

All the stakes should then be set and the plots assigned to the pupils. The pupils should put the finishing touches to the preparation of the soil. Stones and rubbish only should be raked off. The lumps of dirt should be crushed with the rake. The rubbish should not be left in the paths but should be put in some designated dumping place.

When the pupils have finished their task, the plots should be perfectly smooth and the soil in a fine condition. The plots should be kept on a level with the paths, and each pupil should be held responsible for the care of one half of each path surrounding his plot; those who have plots on the sides or ends should be entirely responsible for all the paths which touch their plots only.

309. Planting the Seeds.— If an accurate plan of the garden has been made and if each plot in a series is planted alike, planting becomes a simple matter. Let us suppose that we are going to plant the first series of plots 1, 2, 3, 4 and 5 shown on the plan exactly alike, that is, according to the same scheme.

Set stakes along the outer edge of the end plots, 1 and 5, that is, the upper and lower ends. These stakes should be so placed that their distances from the corner stakes, and the distances between them correspond to those given in planting scheme 1. That is, the first

stake on each end should be placed one foot in from the corner stake; the second, one and a half feet in from the previous stake, and so on. When the stakes are set, the distances should be checked up to see that no mistakes have been made.

When the stakes are properly located, stretch a garden line between the two end stakes placed one foot in from the corner stakes, and plant the seeds in the first row of each plot in the series as described in Chapter XVII. This method is so simple that the planting of the garden is quick work. It is absolutely essential, however, that each pupil having a plot in a series be on hand when that series is planted. When the first row of seeds is planted, move the line on to the next stakes and continue the process.

To accomplish this work speedily the director of the garden work should have the assistance of some of the teachers. There should be three teachers to supervise the planting in each series of plots, two to move the garden line when needed, and see that the work is being done properly, and one to give out the seeds and to hold the plan of the series.

In school garden work, planting is the only busy time. Before any of the actual planting is done, the method of planting seeds should have been carefully discussed with the pupils in the school room as a part of the regular school work. In the garden itself, the planting should be immediately preceded by a brief demonstration. After a plot has been planted, a piece of common white twine may be run around the outside of the plot by fastening the twine to the corner stakes.

This prevents plots from being walked upon before the plants have begun to grow.

310. Cultivation.—Before any cultivation is done in the garden plots, the subject of cultivation should be discussed in the class room until the pupils have a clear idea of why they cultivate and of just how they should do it. Methods of cultivation have been described in Chapter XVII. If the school does not own the necessary implements, the pupils will have to supply their own. Some arrangement, such as a shed on or near the garden grounds, should be made for storing the tools so that it may not be necessary for the pupils to carry the implements back and forth.

311. Garden Accounts and the Garden Diary.—Many schools require that each pupil keep a diary of the garden and a simple account of expenditures, receipts and production. Often these accounts are made a part of the diary. The diary and accounts, together with some garden snap shots, at the end of the season, may be made into neat and attractive garden booklets, enclosed in designed covers. The accounts kept vary; the simplest ought to show all cash expenses and all receipts, whether the vegetables are sold or are used at home.

In the diary, dates of planting the seeds and of the first appearance of the plants make interesting items to enter. The first day a crop is harvested should be noted. Names of visitors to the garden should be recorded. Insects, birds and weeds seen in the garden, the weather from week to week, and its effect on the

growth and condition of the garden are other items of interest.

312. Prizes For Garden Work.— Usually, as an incentive to effort, prizes are offered in connection with the school gardens. These vary and include:—

Prizes for highest final grades on the garden work

- “ “ best display of vegetables
- “ “ best display of some vegetable
- “ “ best kept diary
- “ “ best kept accounts
- “ “ largest profits.

Those prizes offered for the best final grades usually arouse the most competition and produce the best results. A system which may be used to get these final grades follows:

1. The principal of each school appoints a committee of three persons to judge and grade the garden plots at intervals of three or four weeks throughout the growing season.

2. Each judge is supplied with a strip of paper showing a diagram of the school garden with the plots numbered. No names of plot owners are made known to the judges.

3. At each grading, each judge, acting independently passes up and down the paths and selects what he considers the best plot and grades it 100; the second best 95; the third best 90 and the others 75 and 50.

4. He considers the following points:

At the first judging

- a. General appearance of plots
- b. The stand, whether poor or too thick
- c. Straightness of rows
- d. Freedom from weeds
- e. Condition of soil

At subsequent judging

- a. General appearance of plots
- b. Condition of old plants
- c. Freedom from weeds
- d. Condition of soil
- e. The condition of the paths
- f. Condition of succession crops

5. At each judging the marks are sent to the principal of the school and the averages are made out and given to the pupils.

Often at each grading, red, white and blue ribbons are attached to a few plots ranking highest. These are left on the plots for a few days, and then removed, to be used again after the next grading.

6. At the close of the season each pupil is given his final grade and the prizes are awarded to those who receive the highest final marks.

To win a prize one not only must keep continuously at work but must use good judgment. Mistakes made in planting succession crops, or in failing to plant them, cultivating the soil when it is in an unfavorable condition, and failure to harvest vegetables when they should be harvested lower the marks.

7. The last grading is usually made in September after school has opened.

313. Harvesting the Vegetables.— Just as soon as the crops begin to mature, they should be taken home or sold, in measured lots. A quart and peck measure ought to be available for each school garden. Failure to remove mature vegetables at the proper time is an item for which the judges should mark off severely. Many good vegetables are spoiled by failure to harvest them at the proper time.

314. Observational or Demonstrational Plots.— In many school gardens, besides the plots used for vegetables, a number of small plots are used for observational or demonstrational purposes. Sometimes these plots are planted to as many different kinds of flowers or farm crops as it is possible to grow. Many city children have never seen such crops as buckwheat, flax, wheat, barley, rye, oats, soybeans, cowpeas, millet and other common farm crops, grow. To be able to watch them develop and grow is a valuable bit of education to such children.

There is really no limit either to the number of plots, or to their arrangements in school gardens. Each school should change the plan a little each year and try to introduce some new features.

315. School Gardens For Rural Schools.— There are many opportunities for school garden work in rural communities. Beds, three or four feet wide, next to the fence, and around the school grounds, may be used to very good advantage for the growing of shrubs, flowers and perhaps a few early vegetables. Portions of these beds may be used for demonstrational purposes, and in them the pupils should do all the work. In many

rural communities parts of a field adjoining the school grounds are used for the growing of one or more field crops for demonstrational purposes. If these grounds are so arranged that all the work may be done with horses, the cultivation may be looked after easily. Some rural schools run corn, potato, fertilizer and other demonstrational plots, and the sale value of the crops raised usually leaves a good cash surplus to the schools. No school vegetable gardens should be undertaken in rural communities. The place for these in rural communities is on the home farms, and much emphasis should be given to home gardens.

Bulletins for Sale by the Superintendent of Documents,
Washington, D. C.

School Gardening and Nature Study in England, Exp. Sta.

Bul. 204, 5 cents.

German School Gardens, Exp. Sta. Cir. 42, 5 cents.

Some Types of Children's Garden Work, Exp. Sta. Bul. 252,
15 cents.

School Home-Garden Circulars (Send for list.)

Farmers' Bulletins.

The School Garden, F. B. 218.

Frames for Early Vegetables, F. B. 460.

The Home Vegetable Garden, F. B. 255.

APPENDIX

TABLE 1

Suggested References—Government Publications

At the end of each chapter are names and numbers of Farmers' Bulletins (F. B.) published by the U. S. Department of Agriculture, and names of agricultural publications for sale by the Superintendent of Documents at Washington, D. C.

The Farmers' Bulletins will be sent, free of charge, so long as the supply lasts, to any resident of the United States, on application to his Senator or Representative in Congress, or to the Division of Publications, U. S. Department of Agriculture, Washington, D. C. The States Relation Service of the U. S. Department of Agriculture, at Washington, D. C., publishes much interesting material, obtainable on application, for all teachers of agriculture. Each teacher should also have a list of the available bulletins published by his State College of Agriculture. This is sent free.

The United States government is the greatest agent for research work and investigations in all branches of agriculture. Most of its publications are for sale by the Superintendent of Documents, located in the Government Printing Office at Washington, D. C. The prices charged must be paid in advance of shipment. The documents have the freedom of the mails. The Superintendent of Documents has no publications for free distribution but he will send free of charge to anyone, price lists of the various publications he has for sale. The publications pertaining to Agriculture are grouped and numbered as follows:

16. Farmers' Bulletins, Agriculture Department Bulletins, Year-books.
42. Agricultural Experiment Stations.

(Table 1 continued)

- 51. Health, Disease, and Sanitation.
- 64. Standards of Weights and Measures.
- 38. Animal Industry.
- 39. Birds and Wild Animals.
- 40. Chemistry.
- 41. Insects.
- 11. Foods, Cooking, and Canning.
- 31. Education.
- 43. Forestry.
- 45. Roads.
- 44. Plants.
- 46. Soils and Fertilizers.
- 48. Weather.
- 68. Farm Management.

How to Remit

The remittance should be made to the Superintendent of Documents, Government Printing Office, Washington, D. C., by coupons or by postal money order. Postage stamps are not accepted. The coupons are sold by the Superintendent of Documents, and may be purchased from his office in sets of twenty for \$1.00. They are good until used in exchange for Government publications.

Sample Form of Request.

Superintendent of Public Documents,
Government Printing Office,
Washington, D. C.

Dear Sir:

Please send me price list 38, Animal Industry publications, and greatly oblige,

Write your name clearly

Address clearly

State

(_____)

(_____)

(_____)

TABLE 2. PLANT FOOD IN CROPS AND SEEDS

The table below shows the number of pounds of dry matter and the number of pounds of the three elements of plant food contained in 1000 pounds of grains, seeds, cured hay, stalks, stovers, silages, and miscellaneous substances.

Materials	Dry Matter	Nitrogen	Phosphorus	Potassium
<i>Grain and Seeds.</i>				
Corn	894	16.5	3.1	4.7
Rye	913	18.1	3.8	4.8
Wheat	895	19.0	3.8	4.6
Oats	896	18.2	3.4	4.0
Barley	892	19.2	3.4	4.0
Buckwheat	866	17.3	3.0	2.5
Soybeans	883	53.6	4.5	10.5
Cotton Seed	897	29.4	4.6	9.0
Cowpeas	854	32.8	4.4	10.0
<i>Cured Hays</i>				
Timothy Hay	868	9.4	1.4	11.8
Red Top	911	12.6	1.6	8.5
Red Clover	847	19.7	2.4	15.5
Alsike Clover	903	20.5	2.2	11.5
Sweet Clover	908	27.7	2.5	15.2
Alfalfa	919	23.4	2.7	14.8
Hairy Vetch	887	27.2	4.2	20.2
Oat and Vetch	850	20.5	2.6	10.5
<i>Cured Straws and Stovers</i>				
Wheat	904	5.0	1.0	5.2
Rye	929	5.0	1.1	7.1
Oat	908	5.8	1.3	14.7
Barley	858	7.0	0.9	8.7
Buckwheat	901	8.0	0.6	9.5
Corn Stover (no ear) ..	595	6.1	1.7	9.0
<i>Miscellaneous</i>				
Potato Tubers	209	34.8	.7	4.8
Sugar beets	135	24.6	.4	3.1
Corn Silage	264	5.8	.5	3.0
Soy bean silage	258	25.0	1.0	1.7
Tobacco leaves	850	34.8	3.0	35.4
Tobacco stems	850	24.6	4.2	24.4
Milk, whole	128	5.8	1.9	1.7
Buttermilk	100	6.5	1.0	1.7
Butter .....	...	2.0	.5	.25
Fat Cattle .....	...	25.0	7.0	1.0
Fat Hogs .....	...	18.0	3.0	1.0
Barneyard manure	250	5.0	1.5	4.0

To change the wt. of nitrogen, N. to ammonia, NH_3 multiply by 1.2.
 " " " " " phosphorus, P to "Phos. acid," P_2O_5 , multiply by 2.3.
 " " " " " potassium, K, to potash, K_2O , multiply by 1.2.

See Chapter VII for discussion of this table compiled from Henry's "Feeds and Feedings."

TABLE 3. PLANT FOOD IN FERTILIZING MATERIALS

This table shows the average amount of plant food contained in 1,000 pounds of common fertilizing materials.

Material	Nitrogen	Phosphorus		Potassium
		Soluble	Insoluble	
Barn yard manure.....	5.	1.5	...	4.
Sodium nitrate	150.	..	...	...
Ammonium sulphate	200.	..	...	...
Raw bone meal.....	40.	..	90.	...
Steamed bone meal.....	10.	..	125.	...
Raw phosphate rock.....	...	..	125.	...
Acid phosphate .....	...	70.	10.	...
Basic slag .....	...	..	80.	...
Wood ashes .....	...	5.	...	50.
Kanit .....	...	..	...	120.
Potassium chloride.....	...	..	...	400.
Potassium sulphate .....	...	..	...	400.

Compiled from Hopkin's "Soil Fertility and Permanent Agriculture."

TABLE 4. DIGESTIBLE NUTRIENTS IN CROPS AND FEEDS
Average Amount of Digestible Nutrients in 100 lbs. of Common Feeding Stuff.¹

Feeding Stuff	Total Dry Matter in 100 lbs.	Digestible Nutrients		
		Protein	Carbohy- drates	Fat
<i>Concentrates, milk, etc.</i>	Lbs.	Lbs.	Lbs.	Lbs.
Dent corn	89.4	7.8	66.8	4.3
Corn meal	85.0	6.1	64.3	3.5
Corn-and-cob meal..	84.9	4.4	60.0	2.9
Gluten meal	90.5	29.7	42.5	6.1
Gluten feed	90.8	21.3	52.8	2.9
Wheat	89.5	8.8	67.5	1.5
Flour middlings ...	90.0	16.9	53.6	4.1
Wheat bran	88.1	11.9	42.0	2.5
Rye	91.3	9.5	69.4	1.2
Barley	89.2	8.4	65.8	1.6
Oats	89.6	8.8	49.2	4.3
Buckwheat	86.6	8.1	48.2	2.4
Kafir corn	90.1	5.2	44.3	1.4
Linseed meal (op.)..	90.2	30.2	32.0	6.9
Cotton seed meal...	92.6	35.8	23.2	8.0
Dried brewers' grains	91.3	20.0	32.2	6.0
Dried beet pulp....	91.6	4.1	64.9	...
Beet molasses	92.0	6.1	68.7	...

¹ Taken from Henry's "Feeds and Feeding."

(Table 4 continued)

Feeding Stuff	Total Dry Matter in 100 lbs.	Digestible Nutrients		
		Protein	Carbohy- drates	Fat
<i>etc.</i>	Lbs.	Lbs.	Lbs.	Lbs.
Meat scrap	89.3	66.2	...	13.4
Tankage	93.0	50.1	...	11.6
Whole milk	12.8	3.4	4.8	3.7
Skim milk	9.4	2.9	5.3	0.3
Buttermilk	9.9	3.8	3.9	1.0
Whey	6.2	0.6	5.0	0.2
<i>Dried Roughage and Straw</i>				
Corn stover (no ears)	59.5	1.4	31.2	0.7
Timothy hay	86.8	2.8	42.4	1.3
Red clover hay....	84.7	7.1	37.8	1.8
Alfalfa hay	91.9	10.5	40.5	0.9
Wheat straw.....	90.4	0.8	35.2	0.4
Oat straw	90.8	1.3	39.5	0.8
<i>Fresh grass, Silage, Roots</i>				
Corn silage	20.9	0.9	11.4	0.6
Pasture grass	20.0	2.5	10.1	0.5
Mangels	9.1	1.0	5.5	0.2

This table is used in computing balanced rations as described on pages 227 and 228.

TABLE 5. HAECKER'S FEEDING STANDARDS FOR DAIRY CATTLE
Maintenance Requirements

Weight of Cow	Digestible		
	Protein	Carbohydrates	Fat
Lbs.	Lbs.	Lbs.	Lbs.
800	.560	5.60	.08
850	.595	5.95	.08
900	.630	6.30	.09
950	.665	6.65	.09
1000	.700	7.00	.10
1050	.735	7.35	.10
1100	.770	7.70	.11
1150	.805	8.05	.11
1200	.840	8.40	.12
1250	.875	8.75	.12
1300	.910	9.10	.13
1350	.945	9.45	.13
1400	.980	9.80	.14
1450	1.015	10.15	.14
1500	1.050	10.50	.15

(Table 5 continued)
Nutrients Required for Production
(In addition to maintenance requirement)

For each 1 lb. of milk testing:	Digestible		
	Protein	Carbohydrates	Fat
	Lbs.	Lbs.	Lbs.
3.0%	.047	.20	.017
3.2%	.048	.21	.018
3.4%	.049	.22	.018
3.6%	.050	.22	.019
3.8%	.052	.23	.020
4.0%	.054	.24	.021
4.2%	.055	.25	.021
4.4%	.056	.26	.022
4.6%	.058	.27	.023
5.0%	.060	.28	.024
4.8%	.059	.28	.024
5.2%	.062	.29	.025
5.4%	.063	.30	.026
5.6%	.064	.31	.026
5.8%	.066	.31	.027
6.0%	.067	.32	.028
6.2%	.069	.33	.028

Directions for using feeding standards are given on page 225.

TABLE 6. MODIFIED WOLFF-LEHMANN FEEDING STANDARDS FOR FARM ANIMALS

		Digestible Protein	Total Digestible Nutrients
Dairy cows		Lbs.	Lbs.
For maintenance of 1,000-lb. cow.....		0.700	7.925
To allowance for maintenance add:			
For each lb. of 3.0 per ct. milk.....		0.047-0.057	0.286
" " " " 3.5 " " "		0.049-0.061	0.316
" " " " 4.0 " " "		0.054-0.065	0.346
" " " " 4.5 " " "		0.057-0.069	0.376
" " " " 5.0 " " "		0.060-0.073	0.402
" " " " 5.5 " " "		0.064-0.077	0.428
" " " " 6.0 " " "		0.067-0.081	0.454
		Per day per 1,000 lbs. live weight	
		Dry Matter	Digestible Protein
Growing Fattening Steers:		Lbs.	Lbs.
Weight 600 lbs.	23.2	2.0	15.4
" 800 "	21.4	2.0	14.3
" 1,000 "	19.7	1.8	13.5
" 1,200 "	17.3	1.5	12.3

	Per day per 1,000 lbs. live weight		
	Dry Matter	Digestible Protein	Total Digestible Nutrients
Horses:			
Idle	13.0-18.0	0.8-1.0	7.0- 9.0
At light work	15.0-22.0	1.1-1.4	10.0-13.1
“ medium “	16.0-24.0	1.4-1.7	12.8-15.6
“ heavy “	18.0-26.0	2.0-2.2	15.9-19.5
Fattening lambs:			
Weight 50- 70 lbs.	27.0-30.0	3.1-3.3	19.0-22.0
“ 70- 90 “	28.0-31.0	2.5-2.8	20.0-23.0
“ 90-110 “	27.0-31.0	2.3-2.5	19.0-23.0
Fattening pigs:			
Weight 30- 50 lbs.	46.2-51.0	7.8-8.5	41.0-45.4
“ 50-100 “	37.0-40.8	5.5-6.0	32.9-36.4
“ 100-150 “	32.4-35.8	4.4-4.9	28.8-31.9
“ 150-200 “	29.0-32.0	3.5-3.9	25.8-28.5
“ 200-250 “	25.5-28.1	3.0-3.4	22.7-25.0
“ 250-300 “	22.4-24.8	2.6-2.9	20.0-22.0
Wheeler Standards for poultry:			
For hens in full laying—Per day per 100 lbs.			
Hens of 5 to 8 lbs. weight		0.65	3.35
“ “ 3 to 5 “		1.00	5.54

From Henry & Morrison, “Feeds and Feeding—Abridged.”

TABLE 7 — LABORATORY AND SCHOOL SUPPLIES

The following school supply companies and manufacturers have much material pertaining to agriculture for sale. From them may be purchased milk testing outfits, specimens of grains and weed seeds, charts of animals, score cards, litmus paper, chemicals and in fact almost anything needed in the school room. Write for their catalog, stating what kind of material you desire.

Central Scientific Co., Chicago, Ill.

W. M. Welch Scientific Co., Chicago, Ill.

Chicago Apparatus Co., Chicago, Ill.

Industrial Educational Co., Indianapolis, Ind.

The Columbian School Supply Co., Indianapolis, Ind.

The Kauffman-Lattimer Co., Columbus, Ohio.

(Table 7 continued)

L. E. Knott Apparatus Co., Boston, Mass.

The Creamery Package Co., Chicago and Philadelphia, Pa.

(Milk testing supplies only).

The American Fork and Hoe Co., Cleveland, Ohio, and

S. L. Allen and Co., Philadelphia, Pa.

(These two companies handle garden implements).

Crosby Paper Co., Baltimore, Md., and

F. W. Rochelle and Son, Chester, N. J.

(These two companies sell paper pots and bands).

The Prang Co., Chicago, Ill., and New York City.

(Colored construction paper for agricultural booklets).

Gaylor Bros., Syracuse, N. Y.

(Index cards, note book covers, bulletin covers, and gummed letters and numbers).

Modern Mfg. Co., 543 No. Lawrence St., Philadelphia, Pa.

(Paper bands and pots for seedlings).

Denoyer-Geppert Co., 460 E. Ohio St., Chicago, Ill.

(Agricultural charts. Send for list.)

TABLE 8 — OUTLINE FOR TESTING MILK

1. *Securing an accurate sample:* To get an accurate sample of the milk, pour it back and forth from one vessel to another several times, and dissolve the cream that may adhere to the sides of the retainer. The test is worthless unless the sample is well mixed.

2. *Filling the Pipette:* Suck up a little more milk than is needed; that is, have the top of the milk column come about $\frac{1}{4}$ of an inch above the mark on the pipette. Press the tongue firmly against the upper opening of the pipette, and in this position raise the lower end of the pipette above the milk. Place the forefinger of the left hand over the lower opening of the pipette and release the tongue. Then press the forefinger of the right hand firmly over the top opening of the pipette and remove the finger at the lower end. A large drop of milk will fall from the pipette. Now replace the finger at the lower end, and remove the finger at the top

(Testing Milk continued)

for a moment; then remove the finger at the lower end, as before. Continue this process until the column just reaches the mark.

3. *Adding the Milk to the Test Bottle:* Have the pipette in the right hand with the forefinger pressed against the upper end. Hold the milk test bottle in the left hand at a slight incline. Place the lower end of the pipette just inside of the top of the neck. This will permit the air in the bottle to escape. If any milk is spilled the test must be begun again.

4. *Adding the Acid:* Precaution. Sulphuric acid is very strong and must be handled carefully. If any is spilled or gets on the hands or clothing wash it off immediately with cold water. Always keep the bottle of sulphuric acid tightly corked when not actually in use. Fill the acid measure to the mark. Hold the milk test bottle by the neck in the left hand and at an incline; slowly add the acid to the milk allowing it to flow down the lower side of the neck of the test bottle so that the air within the bottle may escape.

5. *Mixing the Acid and the Milk:* With the test bottle still in its inclined position, mix the acid and the milk by means of an even rotary motion. The milk will first coagulate; then the curd will disappear as it dissolves; and the milk will become hot and dark brown in color. The color of the mixture indicates whether or not the proper amount of acid has been added. Quite often the acid is too weak and this condition will give a reddish brown color. In this case more acid must be added until the mixture has a dark chocolate brown color.

6. *Whirling the Bottles:* First time. Number the bottles and place them in the cups of the machine opposite each other and whirl them for four minutes, turning the handle at the speed indicated on the machine.

Gradually bring the bottles to a stop, remove them, and add hot soft water from a beaker or pipette until the contents reach the bottom of the necks of the test bottles.

Second Time: Replace the test bottles and whirl them a second time for two minutes. Then add more hot soft water to bring all the butter fat up into the graduated portion of the necks of the bottles.

Third Time: Whirl them again for another two minutes to free the butter fat of any sediment that may be mixed with it.

7. *Reading the Test:* To get an accurate test the bottles after the whirlings should be placed in a deep water bath so that the fat columns are submerged beneath water, the temperature of which should be between 125 F to 140 F. The bottles should be left in the water bath about five minutes. Then remove them and read the fat columns from the bottoms to the tops of the curved surfaces on top.

8. *Color of the Fat Columns:* The butter fat should have a golden yellow color. If it is dark, either the acid was too strong or too much acid was used; if the color of the butter fat is too light, the acid was either too weak or not enough was used, or the machine whirled too slowly.

9. *Emptying the Bottles* With continuous shaking to dissolve the sediment in the bottom of the test bottle, empty their contents into an earthen jar. Then wash the bottles, first with hot, soapy water, and again with clean water.

Duplicate tests of each sample of milk are usually made. These serve to check any errors in the work, and to establish its accuracy. Test several samples of milk and thus learn the process.

INDEX

- Aberdeen-Angus cattle, 266.
Accounts, in garden work, 344.
Acids, 21; composition, 21; in soils, 21, 22; in roots, 21.
Acid soils, 21-23; appearance of, 23.
Agricultural instruction, growth of, 4.
Agriculture, why taught, 1.
Air, for plant growth, 12; in soils, 20.
Albumin, 271.
Alfalfa, 111; growing the crop, 112; harvesting, 113; history, 112; rich in nitrogen, 71.
Alsike clover, 110.
Ammonia, 65.
Angus cattle, 267.
Apples, 196.
Ash, 215.
Ashes, 51.
Asiatic class of poultry, 234.
Ayrshire cattle, 255.
50; need sweet soils, 23; on legumes, 72; relation to humus, 20; relation to legumes, 71.
Barley, 96, 103; the plant, 103; types, 96; uses, 103.
Beef cattle, 264; beef type, 264.
Bees, 155; the hive, 157; swarming, 156.
Belgian horses, 284.
Berkshire swine, 291.
Birds, 151; their food, 151; how to attract them, 153; useful ones, 152.
Blackberry, 199.
Blight, on potatoes, 119.
Bordeaux mixture, 204.
Brown Swiss cattle, 256.
Buds, 191.
Budding, 187.
Bulbs, 320.
Butter, 276.
Butter fat, 271; testing for, 356.
Buttermilk for swine, 296.
Cabbage worms, 143.
Calcium, 52; how plants get it, 52.
Calf raising, 263.

- Calyx, 8.
Canker worm, 142.
Capillary water, 27; rise of, 28.
Carbohydrates, 218; description of, 218; in seeds, 128.
Carbon, 48; properties of, 48; how plants get it, 48.
Casein, 271.
Cattle, 248; beef breeds, 264; dairy breeds, 250; dual purpose breeds, 251; feeding standards for, 224; grades, 258; judging, 258; pure breeds, 257; rations for, 226; scrubs, 258.
Cereal grains, 96; comparisons of, 96.
Cheese, 277.
Cherries, 198.
Chester White swine, 292.
Cheviot sheep, 301.
Chickens, 232; breeds, 232; feeding, 239; hatching, 244.
Chinch bug, 143.
Clay soils, 17; characteristics, 17; water capacity, 32.
Clover, 70; Alsike, 110; mammoth, 110; medium red, 110; and timothy, 108; nitrogen in, 71.
Clydesdale horses, 284.
Club work for boys and girls, 333.
Coach horses, 284.
Cocoon, 140.
Codling moth, 141.
Cold frames, 165.
Colostrum, 272.
Colts, 287.
Commercial fertilizers, 63; complete, 64; composition, 64; mixed, 64; mixing, 65; uses, 65; value, 64; why used, 65.
Compound, 47; soluble, 53.
Companion crops, 162.
Concentrates, 220.
Conditions of plant growth, 12, 39.
Corn, 79; amount grown, 79; classes, 80; corn belt states, 79; cultivation, 90; dent, 80; diseases, 91; flowers, 82; history, 79; flint, 81; harvesting, 90; hogging down, 297; listing, 89; market grades, 93; pests, 91; the plant, 82; planting, 89; pop, 82; seed selection, 84; seed curing, 85; seed testing, 86; sweet, 81; varieties, 80; uses, 79.
Corn silage, 91.
Corolla, 8.
Cotswold sheep, 306.
Cotton, 120; the plant, 120; growing the crop, 120.
Cottony maple scale, 144.
Cover crops, 68.

- Cowpeas, 113.
Cow testing associations, 258.
Cream, 276.
Crop residues, 63.
Crop rotations, 75.
Cultivation, 42; dust mulch, 43; frequency, 43; of corn, 90; in school gardens, 336.
Cultures of bacteria, 72.
Curing seeds, 10.
Currants, 199.
Cutting insects, 141.
- Dairy cattle, 250; feeding, 262.
Dairying, 249; records, 261.
Delaine Merino sheep, 300.
Dent corn, 80.
Diseases of corn, 91; of potatoes, 119; of poultry, 245; of wheat, 101; mildews, 148; potato scab, 119; potato blight, 119.
Disking, 41.
Dorset Horn sheep, 302.
Drainage, 34; benefits of, 34; methods of, 35; surface drains, 35; tile, 35.
Dry farming, 44.
Dry matter in feeds, 215.
Duroc Jersey swine, 292.
Dust mulch, 43.
Dutch Belted cattle, 256.
- Earthworms, 19.
Education of farmers, 2.
Egg laying contests, 235.
Eggs, care of, 242; production of, 235.
Elements, 47; of plant food, 47; three most important, 48; ten essential, 47.
English class of poultry, 235.
English Shire horses, 283.
Evaporation, 28; from soils, 28; checking, 30; effects of dust mulch, 43.
- Farm plans, 75.
Farmers' friends, 151.
Fat, 219; description of, 219; in seeds, 130.
Feeding, animals, 214; balanced rations, 224, 226; calves, 263; horses, 286; poultry, 239; sheep, 308; swine, 295; standards for, 224.
Feeding stuffs, 214; composition, 214; classes, 220; nutrients in, 220; laws regulating sale of, 218.
Fertilization of flowers, 8.
Fertilizers, 52; commercial, 63, 172; laws, 65; containing nitrogen, 49; phosphorus, 50; potassium, 51; natural, 60.
Fire blight, 147.

- Fixation of atmospheric nitrogen, 74.
 Flats for seedlings, 176.
 Flint corn, 81.
 Flower garden, 319.
 Flowers, 319; annuals, 165; biennials, 166; perennials, 166; fertilization, 9; fruit of, 10; old fashioned ones, 320; parts of, 8.
 Forage crops, 108; alfalfa, 111; alsike clover, 110; cowpeas, 113; clover legumes, 70; red top, 109; soy beans, 113; timothy, 10.
 Forestry, 313; advantages of, 314; law perpetuated, 315.
 Formation of soils, 16.
 Free water, 27; drainage of, 34.
 Frogs, 155.
 Fruit buds, 191; formation of, 10.
 Fungi, 147.
 Fungicides, 204; Bordeaux mixture, 204.
 Galloway cattle, 267.
 Garden, 168; crops, 161; cultivation of, 175; fall management, 179; fertilization, 172; flowers, 319; plan, 169; projects, 323; soil, 168; staking out, 173; school gardens, 336; vegetables, 161.
 Germination of seeds, 133.
 Germs, of seeds, 10.
 Goats, 306.
 Good roads, 310; how made, 310.
 Gooseberries, 199.
 Grade animals, 257.
 Grafting, 185.
 Grains, 96; cereals, 96; varieties of, 98.
 Grapes, 199.
 Grass crops, 108.
 Green manuring, 68; forms humus, 68.
 Green tissue, use of, 11.
 Guernsey cattle, 254.
 Hampshire sheep, 302.
 Hampshire swine, 292.
 Harrowing, 42.
 Hay crops, 108.
 Hens, breeds of, 232; feeding, 239; broody, 242; pelvic bone test, 243.
 Hereford cattle, 266.
 Hessian fly, 102.
 Hilling crops, 92.
 Holstein - Friesian cattle, 252.
 Home and school grounds, 315.
 Home projects, 323.
 Hopkins, Cyril G., 3.

- Horses, 280; breeds, 281; history, 281; Arabian, 282; coach, 284; draft, 282; speed, 281; care of, 285; feeding, 286.
- Hotbed, 163.
- Humus, 16, 20; formation of, 16; from green manures, 68; increases water capacity, 33, 34; rich in nitrogen, 50; value of, 20.
- Hydrogen, 48; properties of, 48.
- Improving a herd, 3, 258.
- Inoculation, 72.
- Insects, 139; description of, 139; classification of, 141; biting, 141, 207; sucking, 143, 209; codling moth, 141; canker worm, 142; cabbage worm, 143; potato beetle, 143; scale insects, 143; chinch bugs, 143; plant lice, 143; control, 145; life history, 140.
- Insecticides, 207.
- Iron, 52.
- Irrigation, 36; application of water, 36; sources of water, 36; where prevalent, 36.
- Jersey cattle, 251.
- Judging cattle, 257, 260.
- Kerosene emulsion, 209.
- Lambs, care of, 307.
- Larva, 140.
- Layering, 185.
- Leaf, parts of, 8.
- Legumes, 70; advantages of, 71; characteristics, 70; forage crops, 108; feeding value, 73; inoculation of, 72; list of, 70; need lime, 74; nodules and tubercles, 71; uses of, 73; uses of their seeds, 73.
- Leicester sheep, 305.
- Light for plant growth, 11.
- Lime, 22; action with acids, 21; how used in soils, 23.
- Lime sulphur, 210.
- Liming soils, 22.
- Lincoln sheep, 306.
- Listing corn, 89.
- Litmus, use in testing soils, 22.
- Loam soils, 17; characteristics, 17; water capacity of, 32.
- Magnesium, 52.
- Manure, 60; amounts to apply, 61; care of, 62; composition, 60; green, 68; low in phosphorus, 61; plant food added by, 60.
- Manure spreader, 61.
- Marsh soils, 18.
- Mash, for poultry, 240.

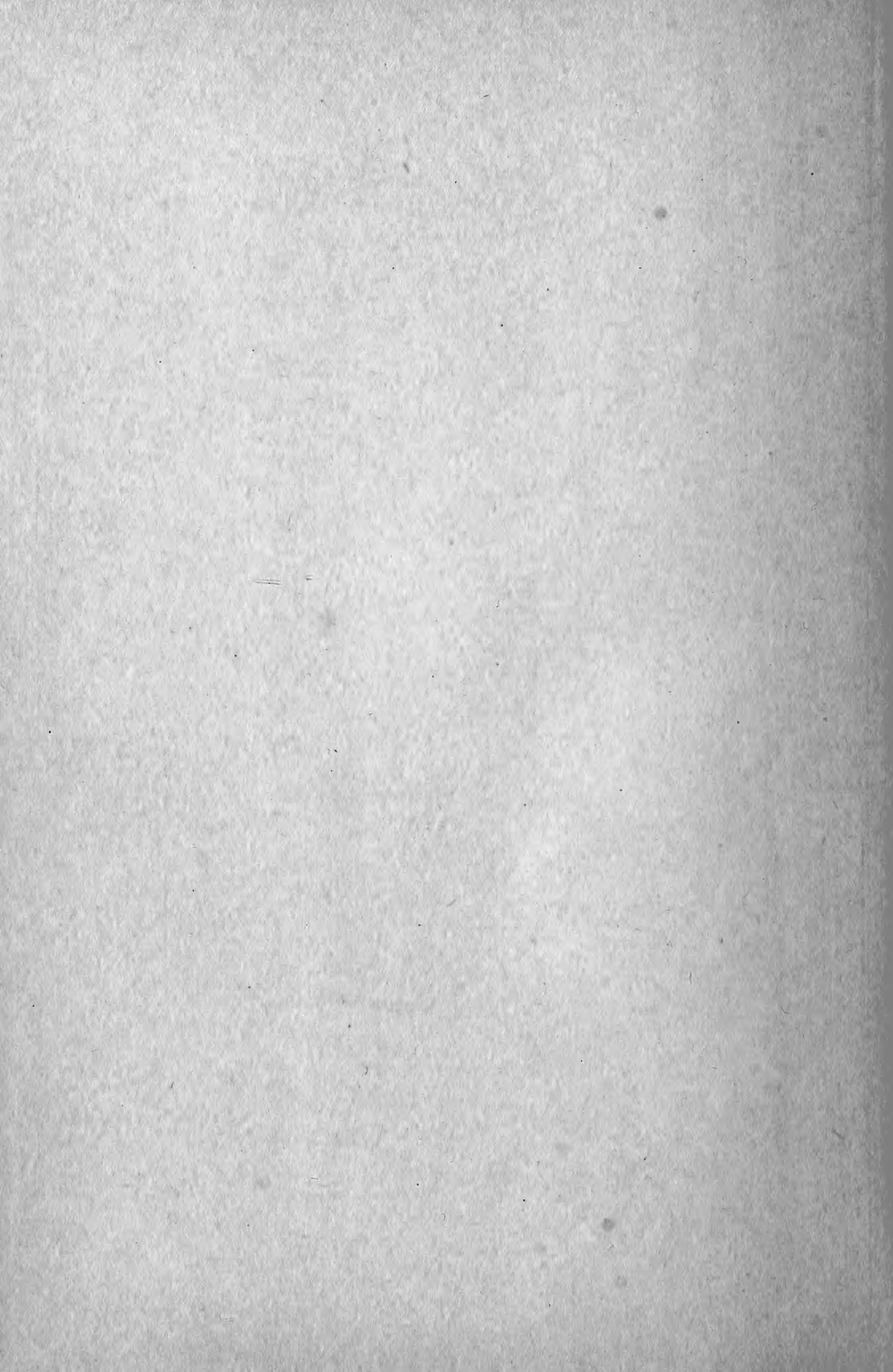
- Mediterranean class of poultry, 233.
Merino sheep, 300.
Mildews, 148.
Milk and its products, 270; composition of, 270; as a food, 270; clean, 248; fat in, 271; souring of, 272; for swine, 296; testing for butter fat, 356; mineral matter, 272.
Mineral soil particles, origin of, 15; agents of decomposition, 15.
Nitrate, 49; formed by bacteria, 50; nitrification, 74.
Nitrification, 74.
Nitrogen, 48; amounts in legumes, 71; amounts removed by crops, 57; from humus, 50; how used by bacteria, 71; uses of to plants, 59; fixation of, 74; properties of, 49.
Nodules, 91.
Nurse crops, 76.
Nutrients, in feeds, 220.
Nutritive ratio, 222; calculation of, 222; narrow and wide, 223.
Oats, 96; cultural methods, 106; market grades, 106; seed improvement, 106; types, 105; the plant, 106; uses, 104.
Oat smut, 106, 148.
Organic matter, 16; in manure, 61.
Orchards, 189; management, 189.
Osmosis, 54.
Oxford sheep, 303.
Oxygen, 48; properties of, 48; action of in soils, 20.
Oyster shell scale, 144.
Paris green, 198.
Peach trees, 198.
Pears, 196.
Peas, 170.
Peat soils, 18.
Percheron horses, 283.
Perennial flowers, 166.
Pests, on corn, 91; on potatoes, 119; of wheat, 101.
Petals of flowers, 8.
Phosphate, 61; fertilizers, 51; conversion into phosphorus, 65.
Phosphoric acid, 65.
Phosphorus, 48; conversion into phosphoric acid, 65; in manure, 61; how a plant gets it, 50; properties, 49; removed by crops, 57; use of, 59.
Physical condition of soils, 39; as affected by plowing, 40.
Pigs, *see* swine, 289.
Pig projects, 325.

- Plant diseases, 146; nature of, 146; fungi, 147.
- Plant enemies, 136.
- Plant food, 11; amount added by manure, 61; amounts in soils, 52; available, 53; unavailable, 53; elements of, 47; evidence of lack of, 59; manufactured, 11; in fertilizers, 64; raw materials, 47; removed by crops, 56; uses of to plants, 57.
- Plant growth, 11.
- Plant lice, 143.
- Plants, importance of, 6; parts of, 6; propagation, 130.
- Plowing, 40.
- Plums, 198.
- Poland China swine, 291.
- Pollen, 8.
- Pollination, 9.
- Ponies, 285.
- Pop corn, 82.
- Potash from potassium, 65.
- Potassium, 51; changed to potash, 65; how a plant gets it, 50; in manure, 61; properties of, 51; removed by crops, 57.
- Potatoes, 116; blight, 119, 149; diseases, 119; growing the crop, 118; pests, 119; scab, 119, 148; seed, 117; varieties, 117; beetle, 119.
- Poultry, 231; industry, 231; classes, 232; egg laying contests, 235; feeding, 239; houses, 236, 237; records, 4; raising, 244.
- Prizes for garden work, 345.
- Projects, home and school, 323; kinds, 327; how to start, 324; reports, 332; story of, 332; list of, 327; planning, 328; results of, 325.
- Propagation of plants, by seeds, 130; by buds, 182; by grafting, 185.
- Protein, 216; composition of, 216; in seeds, 130.
- Protoplasm, 54.
- Pruning, 192.
- Pure bred cattle, 257.
- Rag doll seed tester, 87.
- Raw plant food, 47.
- Rambouillet sheep, 300.
- Raspberries, 199.
- Ration, 220; balanced, 224; balancing, 226; for horses, 286; cattle, 226; calves, 263; cost of, 221; poultry, 239; sheep, 308; swine, 295.
- Red top, 109.
- Registered cattle, 258.
- Rice, 124.
- Root hairs, 7.

- Roots, of plants, 7; acids in them, 21; growth toward water, 31; how they absorb water, 54; osmosis, 54.
- Rotation of crops, 75; benefits of, 75; kinds, 76; planning of, 76; good rotations, 75; reasons for, 75.
- Roughages, 220.
- Rust, of wheat, 101.
- Rye, 96, 103; cultural methods, 103; description, 96; uses, 103.
- Sandy soils, 17; water capacity, 32.
- San José scale, 144.
- Sap, movement of, 7.
- Sawdust box seed tester, 86.
- Scab, on potatoes, 119.
- Scalecide, 211.
- School gardens, 336; accounts, 344; judging, 345; for rural schools, 347; planning, 338; observational plots, 347; planting, 341; preparation of seed bed, 341; prizes for, 345.
- School and home projects, 323.
- Score card for cattle, 259.
- Seed bed, 40; preparation of, 40; operations involved in, 39.
- Seed selection, 131.
- Seeds, 10, 128; classes, 10, 128; curing, 10; food in, 128; formation of, 10; high and low grade, 130; improvement of, 132; of legumes, 73; planting, 173; propagation of plants, 130; selection of, 131; testing, 86; parts of, 10; plate tester, 132.
- Seed corn, 83; selection, 84; curing, 85; testing, 86.
- Seedlings, 176; thinning, 179.
- Sheep, 297; advantages of raising, 297; types and breeds, 298; fine wool, 299; long wool, 299; medium wool, 301; care of, 307; fattening, 308; rations for, 308.
- Shorthorn cattle, 265.
- Shropshire sheep, 302.
- Shrubs, 318.
- Silage, 91.
- Silos, 92; forms of, 92; principle of, 92; value of, 92.
- Skim milk for swine, 295.
- Smut, of wheat, 101; of corn, 91; of oats, 106, 148.
- Sod, a humus former, 63.
- Soil acidity, 21; indications of, 23; disadvantages, 23; appearance of, 23; how corrected, 23.

- Soil surveys, 24; maps of, 24; value, 21; how obtained, 24.
- Soil water, 27; amount in soils, 32; in plants, 24; effects of too little, 30; effects of too much, 31; evaporation of, 28; how increased, 33; movement of, 27; used by weeds, 136; uses, 27.
- Soils, acid, 21, 22, 23; air in, 20; plant food in, 52; bacteria in, 19; classes, 17; cultivation, 42; earthworms, 19; elements of plant food, 47; fertilizers, 60; formation, 16; how they become unfertile, 56; humus in, 20; in good physical condition, 39; light and heavy, 18; liming, 22; origin, 15; preparation of seed bed, 40, 173; sour, 21, 22; structure, 39; subsoil, 14; testing, 22; uses of, wet, 32; water capacity, 32.
- Sour soils,—*See* soil acidity, 21, 22, 23.
- Southdown sheep, 301.
- Soybeans, 113.
- Spraying, 203; kerosene emulsion solutions, 203; Paris green, 208.
- Starch, 6, 11.
- Stems, 7.
- Strawberries, 200.
- Subsoil, 14.
- Sucking insects, 209.
- Sugar cane, 125.
- Sugar beets, 126.
- Suffolk sheep, 304.
- Sulphur, 52.
- Surface drains, 35.
- Swine, 289; advantages of, 289; types, 290; lard, 290; bacon, 293; breeds of, 291, 293; care and management, 294; feeding, 295.
- Tamworth swine, 293.
- Testing milk for butter fat, 356.
- Testing seed corn, 86.
- Testing seeds, 132; plate testers, 132.
- Testing soils, 22.
- Tile drains, 35.
- Tillage, 39.
- Tilth of soils, 39.
- Timothy, 108.
- Toads, 155.
- Tobacco, 121; cultural methods, 122; curing, 123; harvesting, 123.
- Transplanting, 194.
- Trees and shrubs, 318.
- Tubercles, 71.
- Vegetables, 161; classes, 161; companion crops, 162; cold frame for, 165; hotbed

- for, 164; seed bed for, 165;
succession crops, 170.
- Vines, 318.
- Water, amount in soils, 32;
amount used by plants, 30;
as an agent in soil formation,
15; composition of, 27;
in feeding stuffs, 215;
upward movement, 29.
- Weeds, 136; annuals, 137;
biennials, 138; classes of,
136; definition, 136; per-
ennials, 138.
- Wheat, 96; kinds, 99; de-
scription, 99; diseases,
101; growing the crop, 99;
harvesting, 100; pests,
101; production of, 96;
rust, 101, 148; seed, 100;
the plant, 99; uses, 98.
- Wind, as an agent in soil
formation, 15.
- Wounds, of trees, 194;
dressing, 194.



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